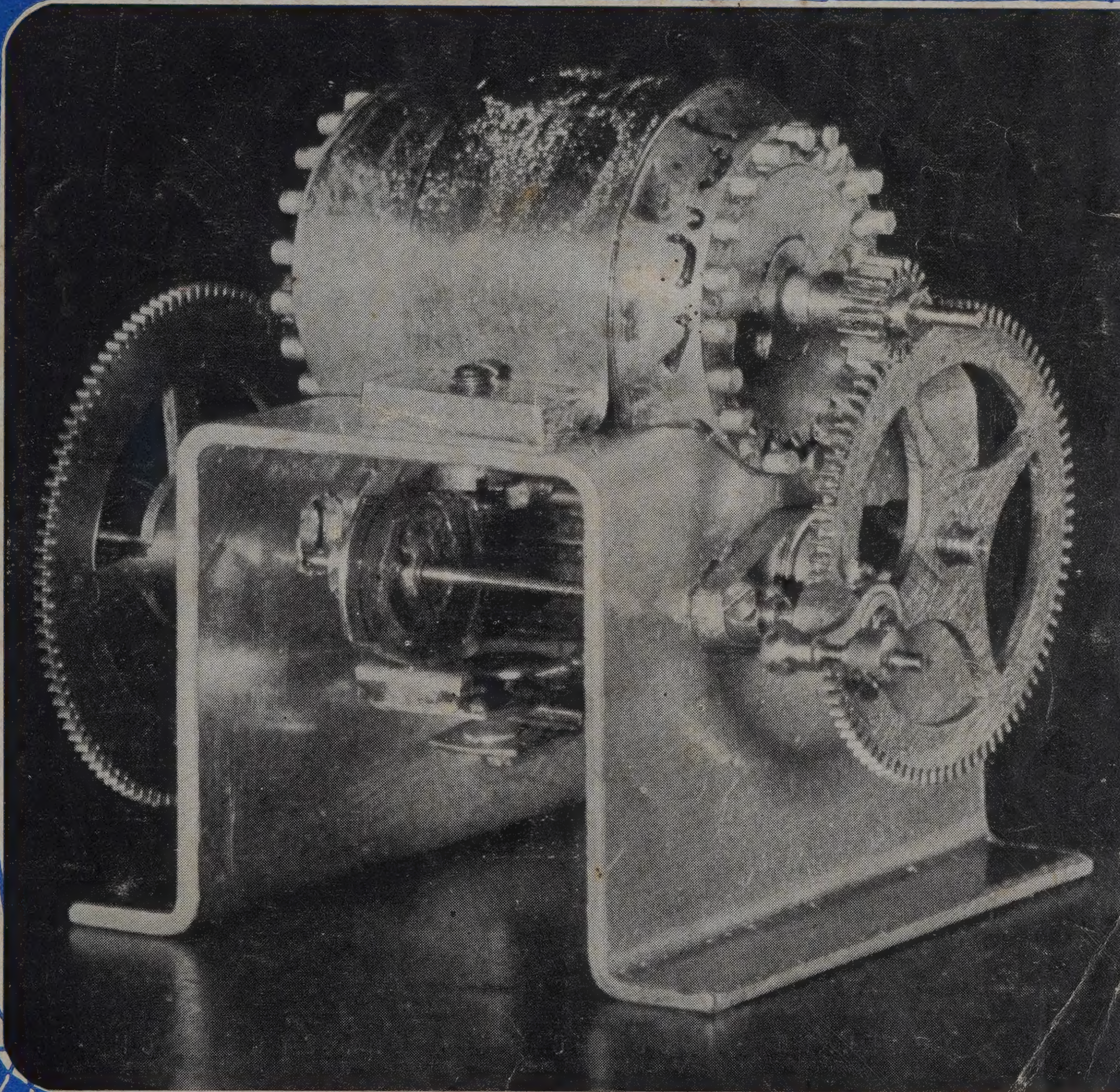
RADIO and ELECTRONICS

ELECTRICITY —— COMMUNICATIONS —— SERVICE —— SOUND



NOVEMBER 1, 1950

VOL. 5, NO. 9

1/10

RADIO and ELECTRONICS

Vol. 5, No. 9 November 1st, 1950

OUR COVER

On the cover is an illustration (greatly enlarged) of the miniature permanent-magnet electric motor and reduction gearing that our laboratory has constructed for use with radio control receivers. This unit is described in this issue.

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CORRESPONDENCE

All correspondence, contributions, and inquiries referring to advertising space and rates should be addressed to:—

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Finance and the Broadcasting Service

According to the report of the New Zealand Broadcasting Service, recently tabled in the House of Representatives, the operations of this Service show a loss for the past year. The matter has excited wide comment in the daily and weekly press, and seems to have aroused considerable concern in some quarters. This is only natural, since government departments are generally supposed to meet their operating costs by their normal receipts, from whatever source these may come. The amount involved is comparatively insignificant, but the point which seems to cause the most unfavourable reaction is that for the previous year, the Broadcasting Service showed a small surplus.

It has often seemed to us that the Broadcasting Service has been used as a peg on which to hang some criticism of a political kind, not always with any reasonable justification. For instance, the size of the receiving licence fee is a hardy annual in the House, and the complaints that have been voiced in past years hardly match up with some of the views being expressed about the so-called loss this year. For example, it has been argued that because in past years the Service has been able to build up substantial reserves, it follows that during those years the licence fee must have been too great. Now, however, after a great deal of money and effort has been spent in providing a considerably improved service, from the points of view of both coverage and programming, some complaints are voiced when an operating loss of approximately £50,000 is sustained. There is one major item of expenditure that more than accounts for the said "loss"—namely, the National Orchestra.

It is not our purpose to criticize, as so many have done, the expenditure on this new national asset. On the contrary, in common with a great many others, we are all in favour of it, and consider it a real asset to the life of the Dominion. Since its running expenses for the past year have been more than double the figure "lost" by the N.Z.B.S., it is clear that the Department would have showed a surplus in the absence of the orchestra.

Another thing that is forgotten too frequently is that in providing additional stations, thereby improving beyond recognition the service rendered to a sizeable portion of the community, extra running expenditure is involved; again we would point out that this extra expenditure *has* been met out of receipts, if the National Orchestra is omitted from consideration.

Clearly, though, the orchestra must be paid for, and its running costs cannot be disregarded in this way. What we do contend, though, is that it is unreasonable to debit the Broadcasting Service with the whole of the cost of running the orchestra, which fulfils a much wider function than that of merely providing a number of broadcast programmes. If that were all the orchestra did, and if it were of a meagre standard musically, then there might be some reason for regarding the expense as unjustifiable. But these things are not so. The worth of an institution like the orchestra cannot be assessed in mere £ s. d., and while we dislike the term "culture" applied to music and the arts, there is no doubt that an active participation in the art of orchestral music is a step towards making the best of civilization as it is known in our time. To return to more mundane considerations: no one would suggest that people would come here from overseas expressly to hear our orchestra, but the possibility of hearing good music while in our country is simply one of the many amenities that are said to be desirable if we are to attract visitors from other countries. This and many other arguments may be put forward in support of the view that the orchestra is a national institution, as its name implies, and if these arguments are granted, then why should its upkeep not be regarded as a national concern? True, the Broadcasting Service has been charged with the job of creating and administering the orchestra, but it has done so simply because it is the logical government department to have charge of such an undertaking. If it were agreed that the orchestra is a luxury that the country cannot afford, then the orchestra should not have been started, but since we have it, it would be a very retrograde step to abolish it, not that anyone has seriously suggested this, but we see no reason why the Broadcasting Service should be criticized, and possibly made to retrench simply because we now have a National Orchestra.

Certainly let the N.Z.B.S. find its operating costs from its available income. Taking everything into consideration, it does very well to provide the service it does with the resources at its disposal, but if Government policy is to improve this service, the Government will have to consider whether an increase in the licence fees will not be necessary. It is sincerely hoped that it will not take this step, for while we do not believe that the present fee is excessive, we agree that an increase is undesirable. If the Government would let the nation take full responsibility for the National Orchestra, by paying for it out of the Consolidated Fund, it would appear that in spite of the recent increases in the service given by the Broadcasting Department, this institution is in fact paying its way. Such undertakings must develop or slip back, and it is very short-sighted policy to hinder the development by what may reasonably be regarded as pin-pricking criticism on not very well founded financial grounds.

THE "R. & E." AMATEUR TELEVISION PROJECT

PART 1—THE PROPOSED SYSTEM

Those who have read the Editorial page in the last two issues of this journal, and who are interested in following the Amateur Television Project through our pages, will have some idea of what this first instalment is about. In it will be found a description of the first part of the project—the production of images on a cathode ray tube screen, the pictures being obtained from still transparencies—negatives or slides. The whole process is broken up into its component parts, and it is shown how it is proposed to tackle the various problems that will be met with.

INTRODUCTION

When it was decided that the time was perhaps ripe for presenting our readers with some television information, the question of just how we should go about this turned out to be perhaps the most difficult one to solve. One way, beloved of technical magazines when they are about to burst forth with an entirely new phase of activity, is to embark on a series of elementary theoretical articles, often in the form of a "course." This approach is excellently suited to those who wish to take up the new subject seriously, and to learn the elements without diving into the more advanced textbooks, which can be tackled at a later stage. Another possibility was to present, without further warning, the circuits and construction of some transmitting and receiving gear, so that amateur transmitters could undertake the provision of the transmitted signals, while anyone who wished could build a receiver. This one is ruled out on several counts. In the first place, the special gear necessary for putting a television signal on the air is not available in this country as yet, and if it were, it would be so expensive as to preclude its use by all but the most opulent of "Hams." If the transmitters could not take it up for these reasons, then there would be no interest or incentive for the builder of receivers, for he would have no transmissions to receive.

Having rejected both these solutions, therefore, we hit upon one which we think is new, and which should enable a great many of our readers, *whether amateur transmitters or not,* to participate, at little expense to themselves. For this reason, the first equipment to be described will not directly enable amateurs to put a television signal on the air. With subsequent modification it will, but the initial equipment will be so excellent for demonstrating the basic principles of television transmission that it is considered that very few amateurs will object to this feature of it. One very great advantage is that in order to operate it, no complex synchronizing gear is needed, thereby bypassing at one fell swoop, as it were, many of the difficulties associated with producing an image in the conventional manner.

As to the gear required, this takes on a very simple form, too. Briefly, what will be required is as follows:

(1) Two cathode ray tubes, one to act as a "camera" tube, and the other as a receiving tube, on which the image will be produced.

(2) A video amplifier, to amplify the signal from the "camera" tube.

(3) A photo-electric cell, to convert the light from the face of the camera tube into a video signal.

(4) Two time-base circuits, one at a high frequency, and producing the horizontal or line scan for both C.R.T.s, and the other at a low frequency, making the vertical or frame scan for the tubes.

(5) A power supply (high voltage) for the cathode ray tubes. The same supply can feed both tubes, thereby reducing the expense.

(6) A low-voltage power supply for the time-base circuits. This has very light current drain, and an ordinary receiving type power supply is quite satisfactory.

WHAT THE ABOVE WILL DO

At the outset, we would like to emphasize that this series of articles will not attempt to give detailed theoretical discussions of the principles of television, for anyone who follows the series through, and particularly who builds the experimental circuits to be presented will have no difficulty in understanding the principles involved. Rather, the articles are designed to give enthusiasts something about television that they can DO, for it is thought that Mr. Wackford Squeers' maxim about "learning by doing" is perhaps more practical in this case than ever his originator foresaw. Besides, we suspect that most of those who will take an interest in television at this stage will be doing so, not from ultra-serious motives, but simply for fun. Nevertheless, we must give some explanation of how the above six pieces of gear produce a picture for us.

First of all, let us imagine that the cathode ray tube that is to be the camera tube has been set up with its power supply, so that when turned on, a spot is present that can be focused, adjusted as to brilliance, and then deflected across the face of the tube. Thus far, the arrangement is quite conventional, and is exactly equivalent to the same part of an ordinary oscilloscope. At this stage, then, we have a C.R.T. with its focused spot, as yet undeflected. The next step is to apply a saw-tooth deflecting voltage to the X plates, just as is done in an ordinary oscilloscope. This will give us a horizontal line on the face of the tube, and this line is repeated some thousands of times a second, so that it appears to the eye to be a continuous, unvarying line, whereas, in fact, it is merely the spot moving so fast, and repeated so often that the eye cannot follow its movement.

The next step in the development of the picture is to apply a saw-tooth deflecting voltage to the vertical plates of the cathode ray tube. This time, though, the frequency will be much lower—only about 50 times a second. Now let us see what evolutions the spot will perform, with both deflecting voltages on at once. It continues to travel across the screen from left to right, and back again, even though it is simultaneously being deflected downward from top at a much slower rate. Because the horizontal deflection takes place several thousands of times a second, and the vertical deflection occurs at only 50 times a second, there will be several hundred horizontal sweeps for several vertical sweeps. The resultant composite trace will thus consist of a large number of almost horizontal lines one above the other, and filling the face of the tube. Clearly, the lines will not be *quite* horizontal, because if the spot is moving slowly downward, each line must slope very slightly downwards, too. The direction of slope will be

from left to right in the present case, since we have said that the horizontal trace travels in this direction. We have assumed, of course, that the flyback of each saw-tooth is so fast that it cannot be seen. In practice, this is not generally true, but it is easily arranged for the spot to be blacked out during both flyback periods.

Such a pattern of horizontal lines, equally spaced in a vertical direction is known as a *raster,* and is the basis of every television image. By controlling the output voltage of the amplifiers which feed the X and Y deflecting plates, the width and height of the raster can be controlled, and in the standard television systems the raster is adjusted to a width/height ratio of 5/4 or 4/3, both of which give a picture of pleasing shape. However, if the greatest possible area of the C.R.T. face is to be made use of, the raster should be square.

The raster is the first requirement for producing a picture. It is traced by the spot in the time taken for one whole vertical sweep and its characteristics have much to do with determining the quality of the final picture. If we remember that the whole raster is traced out every fiftieth of a second, it is easy to see how it can be used as the basis of the picture. The rate of fifty times a second is still great enough to delude the eye into believing that what it sees is a continuous pattern rather than a rapidly moving spot. Now if some means exists of dimming and brightening the spot as it travels along, the result will be that the image is produced on the screen just as if it were a photograph. The control grid of the C.R.T., whose voltage is varied in order to regulate the brilliance of the trace, provides the means by which the spot may be modulated in accordance with the light and shade of a picture. This indicates how a picture may be reproduced on the screen of a second C.R.T., but not how an original picture may be made to produce the modulating signal which will enable the receiving tube to be brightened and darkened in the correct manner.

But suppose we have our camera tube, with a uniformly bright raster on it, made by the two deflections we have been considering. Suppose further that we have a photograph in the form of a transparency. This can be placed in front of the raster, which will shine through it. Thus, as the spot travels over the surface of the tube, its brightness, as viewed *through* the transparency will at every instant represent the degree of transparency of the picture in the place where the spot happens to be at the instant we are considering. Now, if this light transmitted by the transparency is allowed to fall on a photo-electric cell, an output voltage will be produced, proportional to the brightness of the spot at every instant, and therefore at every part of the picture in succession. This voltage can be amplified, and applied to the control grid of the receiving cathode ray tube. Thus, the brightness of the spot on the receiving tube will at all times be proportional to the brightness of the transmitting spot, as seen by the photo-cell through the transparency. This result, however, does not represent a picture on the receiving tube, however, but merely a spot that varies in brightness in a very rapid manner. But all we have to do now in order to re-create the picture is to deflect the spot of the receiving tube in the same way as we do the transmitting spot. The easiest way of doing this is simply to connect the deflecting plates of the receiving tube to the same deflecting voltage as we use for the transmitting one. This produces a raster on the receiving tube that corresponds exactly

(Continued on Page 48.)

PART II

FOUR STANDARDS TAPE SPEEDS

The standard tape speeds, and their purposes, are as follows:—

Purpose.	Frequency Range.	Tape Speed
Speech only	200 to 2,500 c/sec.	$3\frac{3}{4}$ in/sec.
Speech and music	100 to 5,000 c/sec.	$7\frac{1}{2}$ in/sec.
High quality speech and music	50 to 10,000 c/sec.	15 in/sec.
Broadcast and studio speech and music	30 to 15,000c/sec.	30 in/sec.

SPOOL SIZES AND PLAYING TIMES

As well as standardizing on tape speeds, three standard spool sizes have been decided upon. These are 5, 7, and 11 inches in diameter, and contain 600, 1200, and 3250 ft. of tape respectively. At the slowest speed, $3\frac{3}{4}$ in/sec., these lengths play for 32, 64, and 172 minutes respectively. At the fastest speed of 30 in/sec., the playing times are 4, 8, and $21\frac{1}{2}$ minutes. Most recorders turned out for home use run the tape at $7\frac{1}{2}$ in/sec., and have room for 7 in. spools, so that on this basis, one reel of tape gives 32 minutes of continuous playing. All tape is standardized at $\frac{1}{4}$ in. in width, and since there is no necessity for the whole width of the tape to be used for a single record, some machines are made so that two recording tracks are made on the one tape, side by side, thus doubling the amount of material that can be got on one reel.

ERASING THE RECORDING

As has been said, one of the most valuable features of tape recording is that one can either keep records as a permanency, or else the recording can be erased completely, leaving the tape in an unmagnetized condition, ready for use all over again, for as many times as we please. This makes the operation of a tape recorder very economical, especially for purposes in which the record is wanted for only a short time, after which it can be destroyed. The question arises now as to how this erasure is brought about. We have already seen that a supersonic frequency is mixed with the audio frequency signals fed to the recording head. Now if we greatly increase the level of the supersonic frequency that is fed in, and pass the tape over the head once more, the result is that the tape becomes demagnetized, thereby removing the record already on it. The point is that the supersonic flux in the gap must be made strong enough to take every magnetic particle in the tape through the magnetization cycle several times while it is passing through the gap. Moreover, it must take them to saturation in order to wipe off all traces of previous magnetism.

A requirement of the erasing and the bias waveform is that in both cases, it should be as pure a sine-wave as possible. Any harmonic content—particularly even harmonics—in the waveform is equivalent to the complete recording process, and the result will be (a) incomplete erasure, and (b) noise during recording, since the effect will be that of a D.C. bias, as explained above.

Another method of erasing is very simple to use, but is not quite so good as the supersonic method. It is to use a permanent magnet, and to pass the tape over its poles. This gives very complete erasure, but tends to leave the tape in a noisy condition. It is thus never used on instruments of the highest quality.

SOME OF THE PRACTICAL ASPECTS

So far, we have been dealing mainly with the theory of magnetic recording, and there are no doubt many who will want to know something about the purely practical aspects of the business. Such matters as how the tape is moved at constant speed, and how the heads are arranged, and what has to be done in the amplifier circuits to ensure a flat response will be dealt with under this heading.

TAPE MOVEMENT

The problem of moving the tape past the recording and playback heads at constant speed is quite a difficult

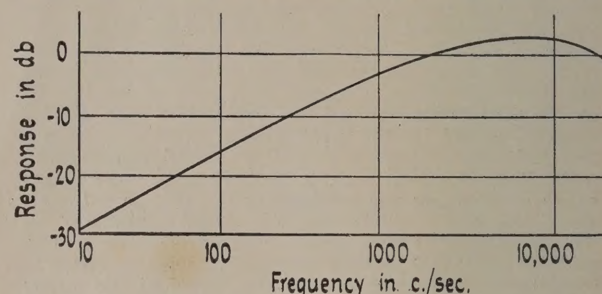


FIG. 7

one, and in this respect, tape recording is no different from other systems such as disc and film recording, where equally bad or even worse mechanical problems have to be solved. The tape is stored on reels, so that in recording and playback, it has to be wound off a reel at a constant linear speed. But since the diameter of the stack of tape is constantly changing as the reel unwinds or winds up (in the case of the take-up reel) constant tape speed means anything but constant rotational speed of the reels. It is thus not possible to use any drive system that involves driving the reels in order to move the tape. In other words, any system that is used must drive the reels only as a secondary consideration, and the usual drive mechanism does this. The most satisfactory scheme is known as the capstan drive. The capstan consists simply of a shaft round which the tape is wrapped for rather more than half a turn, and less than a whole turn. It is kept in tension sufficient to hold it firmly against the capstan by friction, and it is this friction which drives the tape at the exact speed of the rim of the capstan, without slippage. There is usually a system of guide wheels or posts through which the tape is threaded in order to exert a little frictional tension on that part of the tape that runs from the reel to the head. These guides also ensure that part of the tape runs past the head accurately in contact with the gap. After the head comes the capstan drive so that the tape is pulled past the head. The only remaining thing to do is to drive the take-up spool. This presents a little difficulty, since the spool has to rotate at different speeds, depending on how much tape is already on it. The usual scheme of allowing for this is to drive the take-up spool from the same motor which drives the capstan, by means of gearing or belts, at a speed slightly faster than the spool will ever be called upon to run at. Then for the slower speeds that are required when the reel is not full, use is made of a slip-

ping clutch which allows the take-up spool drive to rotate faster than the spool itself at all times. A very simple way of doing this is that used on home movie projectors, where the take-up spool is driven by a spring type of belt which can slip just as much as is required.

In Fig. 8 is a diagram of the usual kind of threading run for the tape, showing the guide posts or wheels, the capstan, and the reels. The arrow shows the direction of travel of the tape during recording. Once a record has been made, it is necessary to wind the tape back on to the original reel before it can be played back. This is usually done by bringing in a drive on to the left-hand spool, and letting the right-hand spool run free. This drive is engaged by a lever and disengaged once more when the tape is fully wound back. In some instruments, separate motors are used for driving the capstan, the take-up reel, and the reel which is unwinding, but many systems use just the one motor for all three purposes.

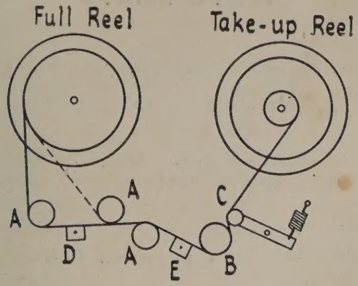


FIG. 8

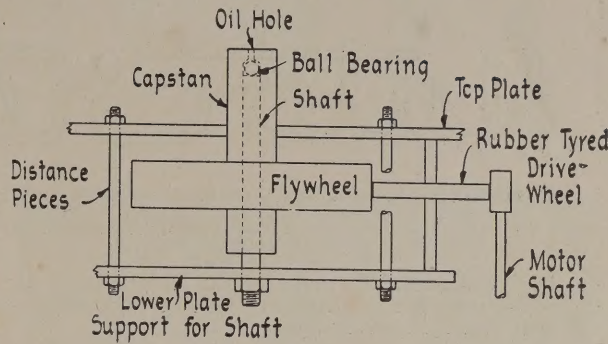


FIG. 9

The most pressing question in designing the tape-pulling mechanism is how to drive the capstan from the motor. Gearing can only be used in very expensive mechanisms, for gears that are free from speed variation are difficult to make, and thus expensive. Most machines use either belts, or rubber-tyred wheels acting as a gear train. The latter system is perhaps the easiest to use, for as long as the tyres on the driving wheels are accurately made, and have no flat portions on them,

(Continued on Page 46.)

Autocrat

DOUBLE-UNIT AUTO-RADIO ★

This is the first of a series of three advertisements featuring circuits, etc., of Autocrat Car Radio. Next issue will feature the Six-Valve Speaker Unit.

Designed to fit any make of car simply and with a minimum amount of space. Made in two units, consisting of a small tuning unit of high efficiency connected by a special cable to a 6 in. speaker unit and the power supply.

CURRENT CONSUMPTION

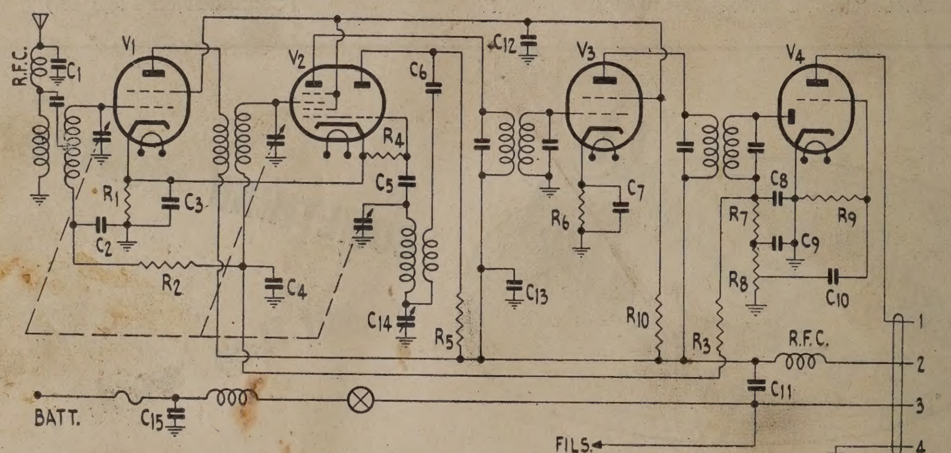
The current consumption of Autocrat Car Radios is remarkably low, and provided battery is in normal condition no strain will be placed on the electrical system.

Six-valve models: Six volt 4.2 amps; Twelve volt 2.5 amps.

Eight-valve models: Six volt 4.8 amps; Twelve volt 2.8 amps.

THE AUTOCRAT TUNING UNIT

The location of the tuning unit will be determined by the type of vehicle to which the receiver is being fitted. In the majority of cases the best location is on the right-hand side of the steering column. The unit is held in place by two self-tapping screws; the position of the holes on the mounting bracket should be marked on the underside of the dash panel and drilled with a $\frac{1}{8}$ in. drill. ; the unit is then mounted in position. A rear mounting strip is supplied, and should be fastened to the small bolt on the rear of the unit and to a suitable position on the bulkhead of the car.



C1, 15PF Ceramic	C10, C11, .01 Paper	R3, 1meg. $\frac{1}{2}$ watt	R9, 10 meg. $\frac{1}{2}$ watt
C2, C3, C4, 0.5 Paper	C12, C13, .1 Paper	R4, R7, 50k. $\frac{1}{2}$ watt	R10, 50k. 1 watt.
C5, 50PF Mica	C14, 600 Padder	R5, 20k. $\frac{1}{2}$ watt.	V1, V3, 7B7
C6, 250PF Mica	C15, .5 Paper	R6, 1000 ohms $\frac{1}{2}$ watt	V2, 7S7
C7, .02 Paper	R1, 200 ohms $\frac{1}{2}$ watt	R8, 500k. Vol. Control	V4, 7C6
C8, C9, 250PF Mica	R2, 250k. $\frac{1}{2}$ watt		

Intermediate frequency 465

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A RELIABLE MINIATURE ELECTRIC MOTOR

In our researches into the design of remote control equipment for model aircraft, the need was felt for a reliable miniature electric motor, together with a suitable reduction gear and escapement mechanism. Existing commercial motors do not fill the bill, and so it was decided to design and build a motor that would. This article describes the construction of the complete actuator unit.

INTRODUCTION

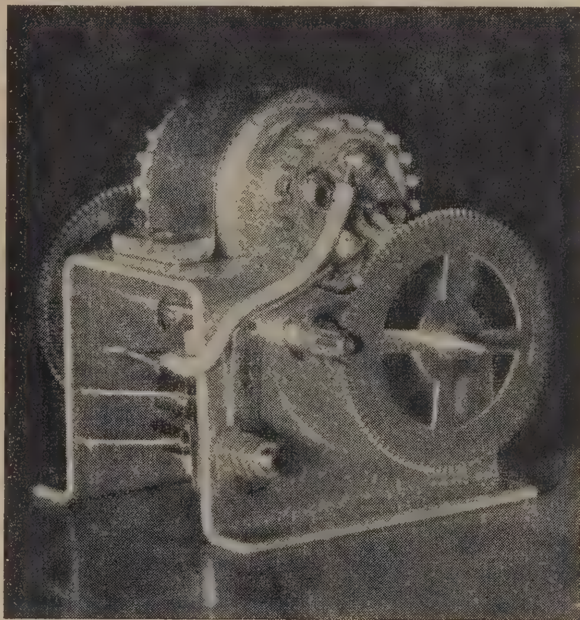
Since the production of the May 1950 issue of *Radio and Electronics,* which was devoted almost exclusively to the subject of remote control of models by radio, the need has been felt for an extremely robust and reliable actuator mechanism that would match the strength and reliability of the miniature three-valve receiver that was described in that issue. At first sight, the Electrotor, a small permanent-magnet motor which is available commercially from a variety of shops, appeared to be ideal for the purpose, since it is cheap, light, and light on battery consumption. In fact, a number of radio control enthusiasts have been using Electrotors for some time. These motors, however, have an unfortunate habit of refusing to start sometimes. This does not happen very often, but quite often enough to make them the least reliable part of the whole control system if they are used as the motive power for the control actuator. In many cases, a failure of the control due to a non-starting motor does not matter very much, but to the user, it can be a very serious matter, and can cause the write-off or loss by flying away, of an expensive and well-constructed model. It is of little use to build or try to build reliable radio gear for a special purpose like this, only to have one's efforts set at nought by an unreliable electric motor!

For most purposes to which the Electrotors are put, the fact that they sometimes need a flick to make them start is little or no disadvantage, but for the purpose in hand, such behaviour cannot really be tolerated. For this reason it was decided to see what could be done by way of building a suitable motor. For radio control purposes though, it is not enough simply to have a useful motor. This must in turn be geared down to a suitably slow rate of rotation so that the final shaft can turn the rudder or other control surface at a reasonably slow speed. In addition, it is necessary to have an electrical escapement mechanism such that once the motor has started, in response to a signal sent to the receiver, it will drive the final shaft through a quarter of a turn, and then automatically stop. After this, when the receiver relay has been de-energized, the motor must start again, and drive the final shaft a further quarter turn, thus returning the control surface to the neutral position. This requirement has been fully described in the previous articles that have appeared in this and other publications on the subject. (*Radio and Electronics,* September 1949, December 1949, and May 1950.) There is thus no need to elaborate further the principle of the sequential actuator, which has been dealt with in the above-mentioned issues. However, enough has been said to indicate that once the motor and gearing have been provided, some kind of electrical escapement must be provided in order that the final drive shaft may perform only its quarter turns, at the behest of the transmitter. The present article, therefore, describes not only the construction of the motor itself, but also the gear-train, and the contactor arrangement which gives the automatic quarter-turn effect.

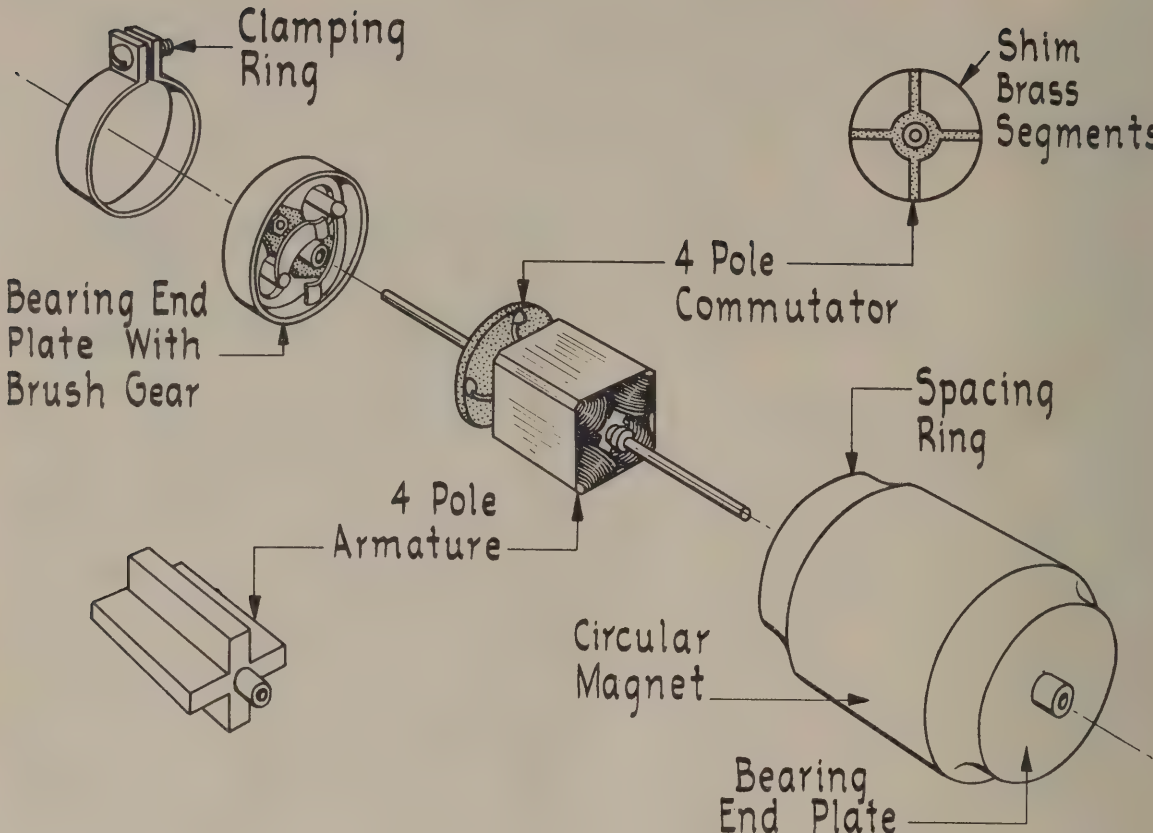
CONSTRUCTION OF THE MOTOR

In building a small motor it is possible to tackle the matter in two ways, and it is necessary to decide at the start which will be used. If an electro-magnetic field is used, certain advantages arise, for the electrical design is then under complete control. For instance, it is then possible to decide from the outset what battery voltage and current the motor will take, and to make an approximation of the power input and output. But it is not necessary to go to these lengths, for only the minutest amount of power is necessary, since the large reduction gear ratio will see to it that plenty of torque is available from the final shaft. It would be necessary to work out a full design, as for larger motors, only if it was essential for the battery power to be an absolute minimum. The alternative is to use a permanent magnet for supplying the field, and this has decided constructional advantages, assuming that a magnet of suitable dimensions and shape is available. It is quite impossible to obtain permanent magnets of the shape usually used for the cores of wound-field motors, so at first sight this simplification might appear impossible. But although the Electrotor has been found wanting in its original form, it has a small and light permanent magnet admirably suited to the production of a motor of quite different design. It was decided, therefore, to use the magnet from an Electrotor to supply the field, and also to make the greater part of the frame of the new motor.

The magnet of an Electrotor is in the form of a hollow cylinder, and it is magnetized with its two poles



This is another view of the completed motor and its reduction gear. The motor itself is on top of the rectangular framework which holds the gear train, and this photograph, too, is a little larger than life. The actual diameter of the large gear wheel is $1\frac{1}{8}$ in



An exploded view of the motor itself. Apart from the magnet, which comes from an Electrotor, all the parts are from disused K.W.H. counter mechanisms.

at opposite ends of a diameter of the cylinder. We thus have a two-pole field magnet ready made, and it is only necessary to dis-assemble an Electrotor to get it. Of course, this means that an Electrotor has to be purchased, unless one has an unserviceable one lying around, as we did. But since this represents almost the whole of the monetary outlay for building the motor, it should be able to be afforded by most of those interested!

A glance at the exploded view of the motor will show that the rest of the motor consists of a four-pole armature and commutator, which are constructed out of pieces of scrap and other oddments. But before starting on a description of how to go about building the motor, the source of the remaining bits and pieces for the whole actuator should be indicated.

PARTS FROM OLD COUNTER MECHANISMS

There have been on the market for some time, the remains of disused kilowatt-hour meters, as used by electricity supply authorities in everyone's homes. It is not necessary to have the whole of the K.W.H. meter, as the only part needed is the counter mechanism from it. There are two main sorts of counters used in these meters. One gives its indication on a number of dials, each with its own small pointer. The whole counter consists of a beautifully made gear train, driven from the original meter's motor. In the train, successive reductions are in the ratio of 10 to 1, so that the various dials are simply driven from extension shafts on each gear wheel. This is the type NOT to get, because the gear trains are put together very much in the same manner as a watch. That is to say, the ends of the gear shafts are turned down to a smaller diameter than the rest of the shaft, and inserted in small holes in the frame. These holes act as bearings, and the shoulders on the shafts, caused by the ends having been turned down, act as stops to prevent too much end-play. For this reason, it is almost impossible to make use of these gear-trains unless they are used unmodified, and they do not lend themselves very well to making anything else out of them.

The other main kind of counter has a series of small windows, side by side, and small numbered drums are driven past the windows. The mechanism is very familiar —almost identical, in fact—to those used in car speedometers and cyclometers for indicating mileage. Now the drums are driven by a small gear train in these counters, but the best thing about them from our point of view is that the whole counter mechanism is put together in such a way that the gears, their shafts, the drums, and, in fact, all the component parts, can be disassembled and used to make up any desired arrangement of gearing. This is because they are constructed like Meccano. The gear wheels all have little set-screws to attach them to the shafts, and there are minute collars, also with set-screws, to prevent end-play. There are even exceedingly small washers which can be used as spacers or thrust washers. In fact, by buying two or three of these counters, we get enough parts to build almost an un-

limited variety of gear trains, to suit this or any other purpose. Just to help a bit more, it will be found that there are several types of this main kind of counter. They differ, however, only in that the ratios of the initial drive are different, having been made, presumably for use with motors designed to run at somewhat different speeds. But here is the catch! In spite of this, the shaft spacing for all the different gear ratios is the same, so that we have a wide variety of possible gear ratios that we can build up. The counters are so admirably suited to the purpose that a very efficient and free-running gear train can be built without our even having to make bearings for the shafts. Indeed, the whole job can be done with the most elementary tools, such as a hacksaw, some files, and a screw-driver.

The photograph on this month's front cover is a very much oversize illustration of the finished motor and gear train. It also includes a cam, driven from the final shaft, and visible in the photo; this cam operates a movable contact, which performs the necessary switching for giving the quarter-turn movements of the final drive. It has the advantage over previous arrangements for doing the same thing that it eliminates sliding contacts completely. The power of the final drive shaft is such that very firm contact can be used between the cam-operated leaf and the other two, and it has been found that completely reliable operation is secured even with the whole arrangement flooded with oil—a condition that will hardly be met with in practice.

The photograph shown here is also a little larger than "life-size" and shows the other side of the mechanism. It can be seen that two reductions are used, one from the motor shaft to an idling shaft, and from this to the final shaft. The total reduction is approximately 50 to 1, but this can be varied by choosing different gear wheels for the two reductions. The photograph on the front cover reveals the business end of the final drive, ending in a small crank. On the crank, which is made from a gear-wheel by removing all but the hub and one spoke, and then soldering a collar, complete with its set-screw, on to the end of the spoke. A small length of shaft is inserted in the collar, and is provided with a further collar to act as a retainer for the push-rod that will in practice be driven by the crank.

MAKING THE MOTOR FRAME

In making the motor, the first job is to fabricate the frame. The main body of this consists of the Electrotor magnet, but in order to run an armature inside it, it is necessary to have a bearing at each end. In the original Electrotor, these bearings consist simply of holes in a pair of small fibre plates, which are held one on each end of the magnet. These soon wear with use, and become very slack, and this constitutes a second major disadvantage of the Electrotor as originally constructed. To make good bearings for the motor shaft, then, is the first essential and luckily, we have them ready made in the numbered drums from the counter. These drums are mounted on a steel shaft of the same diameter as is used for all the gear-wheel shafts, and so it is possible to use the drums as bearings for the motor shaft. In the photographs, and particularly in the large one, the use to which the drums have been put can be seen. The back bearing is made from one of the drums. The only modification needed is to file off the two small engaging lugs from the plain side, so that this can sit squarely on the end of the magnet. The drum is now ready for soldering to the magnet end. The actual soldering should not be done until the armature has been made, and assembled on the shaft, but before the windings have been put on. This is because the armature can be used as a centring

device, to hold the drum which is to be used as the end plate and bearing in exactly the correct position for soldering to the magnet, and so that while soldering is in progress, the drum will not shift.

Thus, we will assume that the armature has been made, and fitted to its shaft. The armature diameter is such that only a very small clearance is left between it and the inside face of the magnet, but since the latter is accurately circular, and since the bearings to be used are so accurate, a very small clearance is all that is needed. In order to align the bearing, paper is wrapped round the armature until it is a neat push fit into the magnet. When inserted in this way, the drum to be used as a bearing end-plate is slipped over the shaft, which holds it accurately in place while the soldering is done. Now in performing this operation there is a difficulty that has to be overcome by very careful work. The trouble is that the drums are made of white-metal, which has a very low melting point, so that if the soldering iron is left in contact with it for more than half a second or so, it just melts away! This need not cause much dismay or despondence, though, because to make the whole motor only three of the drums are required, and there are quite a number of spares available with which to experiment. However, if the soldering is carried out in the following way, little difficulty will be expereniced, and a little practice will enable the builder to perform the rather ticklish operation quite successfully. First of all, some killed spirits, or plumbers' soldering fluid is obtained, and this is used to tin the bright end surfaces of the magnet. The surfaces should be tinned, and then wiped while the magnet is still hot so that only a very thin layer of solder is left. This, of course, is done before the armature is placed inside in the manner described above. Now, with the magnet faces tinned, and the armature inside the magnet and its shaft acting as a guide for the end-plate, some solder is melted with the iron and allowed to drop into the angle between the magnet and the end-plate. This should be done as close as possible to the job so that on the one hand, the solder has not had time to cool while dropping into position, and on the other, the iron does not remain in contact with the white-metal and melt it. The iron can be placed in contact with the magnet so that this becomes hot, and the solder "takes" when it is run on to it. This gives a small spot of solder at one point on the circumference of the join, and if it has been done correctly, the solder will have taken to the white-metal, too. If not, it does not much matter, in the first instance. The next step is to turn the assembly through 180° and place another spot of solder opposite the first one. Then, two more spots are put on, making four in all, evenly spaced round the circle. Before the armature is removed, the soldering iron is carefully applied to each spot of solder, making it run, and ensuring that it takes to the white-metal. This is the ticklish part, because too much heat will melt the metal, while too little will result in no joint, or a dry one. However, as we said earlier, it can be done, if care is exercised, and in any case, mistakes are not irreparable. When the initial four spots are soldered. further spots can be placed round the circumference so that when all of them are melted to make proper joins, they flow together and give a continuous ring of solder right round. It does not matter if the result does not look very neat, since it is possible to take a small round file and remove any excess solder, at the same time making the whole thing nice and smooth, as indicated in our draughtsman's illustration. It is advis-

able not to withdraw the armature from the magnet until the solder has all been applied, so that there will be no possibility of the bearing becoming mis-aligned during the process.

When this has been accomplished successfully, the builder will be quite adept at soldering the white-metal without melting it, and can undertake the next step with more abandon! It consists in soldering another counter drum to the other end of the magnet, which, like the first, must be tinned also. This drum makes what is described on the drawing as the Spacing Ring. This drum has to be prepared a little before it is soldered to the magnet. One edge of each drum has a large number of projections all round it, and the other side has only two projections. Preparing the drum consists in carefully filing off the projections from both sides. This is quite easy to do, as the metal is so soft, but for the same reason care is needed to see that on removing the projections, the edge of the drum is left quite flat. After the projections have been removed, this drum is aligned on the remaining end of the magnet by the same process as was used for the first one. This means that after the second one is fixed in place, the armature is completely enclosed, but the succeeding process of finishing the spacing ring frees it and allows it to be withdrawn once more. It is important to note that the drum that is to be the spacing ring must be put on the shaft *the right way round. This is done so that the end of the drum which used to have the large number of projections is towards the magnet face*. The reason for this is that the outer end of the spacing ring is used to locate the other end-plate, which carries the second bearing and the brush gear. Thus, if the spacing ring is not accurately located, and if the outer face is not flat and true, the end bearing will not align properly. Since only two small projections have to be filed off the outer end of the drum which forms the spacing ring, the chances of this face of the ring being true are much better than those of the other side, which is subjected to a good deal of filing in removing the projections.

When the second drum has been prepared, and set up in position as described, it is soldered to the magnet just as the end-plate was. Now comes the job of removing the centre portion of the second drum, thus turning it into a simple ring. Of course, it would have been possible to remove its inside before soldering it to the magnet, but this would have made it impossible to set it in position with anything like the accuracy that is obtained by using its centre portion as a temporary bearing for locating purposes. The inside of the ring can be carefully drilled through with an $\frac{1}{8}$ in drill in several places, after which the centre portion can be broken out using a pair of long-nosed pliers. Once this is removed, a small half-round file can be used to remove enough of the material to allow the armature to be removed, after which the inside is easily cleaned up with the same file. At this juncture we have the magnet with one end bearing, and the spacing ring in position, as shown in the drawing.

Unfortunately, a description of operations like this takes a long time to read, and one tends to gain the impression that the construction is more difficult than it really is. Although the right methods of doing things take some time to describe, the steps involved are really

(Continued on Page 48.)

THE "RADIO AND ELECTRONICS" ABSTRACT SERVICE

AUDIO EQUIPMENT AND DESIGN:

A voice-switched intercom. The talk-listen switch is eliminated by using a repeater with flip-flop vibrator that unblocks gated amplifiers alternately 30 times a second. The arriving voice signals stop the flip-flop and keep the desired channel open without clipping syllables.

—*Electronics* (U.S.A.), August 1950, p. 79.

It is conventional today to operate power output tubes in Class AB1, the average plate current swinging from low quiescent value to one much higher. A power supply is designed to have the necessary regulation to meet the varying current requirements.

—*Radio and Television News* (U.S.A.), August 1950, p. 47.

Equipment is described for testing turntables for wow, rumble, and speed. The instrument allows rapid testing of machines from the production line.

—*Electronics* (U.S.A.), July 1950, p. 78.

CIRCUITS AND CIRCUIT ELEMENTS:

Certain ideas and circuits are given for giving better results on 420 mc/sec. with designs for receivers and transmitters for the U.H.F. experimenter, with some notes on super-regeneration.

—*QST* (U.S.A.),, August 1950, p. 11.

The design of phase-splitting circuits to produce constant phase differences over wide frequency bands has been frequently discussed. Here the matter is treated very fully and mathematically.

—*Proceedings of the I.R.E.* (U.S.A.), July 1950, p. 754.

ELECTRONIC DEVICES:

Hair removal by means of electricity is not new, but constant demands for safer, more permanent, and less painful methods have led to the development of electronic devices, one of which is described here.

—*Electronics* (U.S.A.), August 1950, p. 87.

The essential qualities of a good hearing aid instrument are stated, and the methods of their practical realization.

—*Wireless World* (Eng.), August 1950, p. 275.

One of the most interesting hobbies is model building, and here is given in some detail the construction of an instrument for controlling model planes and boats.

—*Radio and Television News* (U.S.A.), August 1950, p. 29.

To the growing list of electronic musical devices is added an electronic musical novelty which is stated to have a beautiful tone all of its own. It is based on the piano keyboard and an individual oscillator for each key permits any number of notes up to a full 66-note keyboard.

—*Ibid*, August 1950, p. 39.

A modulated light densitometer. The instrument is for determining reflectivity and density of materials with low light intensity. An incandescent dial light is 100 per cent. modulated at 20 cycles to operate a phototube.

—*Electronics* (U.S.A.), July 1950, p. 85.

Geiger Counter for lectures—circuit and construction details of a portable counter providing up to 50 watts audio output for demonstrations.

-*Electronics* (U.S.A.), July 1950, p. 105.

The paper gives a general account of the recently discovered conduction type counters—the nature of the counting phenomenon, preparation of crystals, types of useful crystals and experimental technique. The counters are adopted to the counting of ionizing particles.

—*Proceedings of the I.R.E.* (U.S.A.), July 1950, p. 726.

The recording tube is a cathode-ray type of storage tube embodying a new operating principle which enables reading to be accomplished without disturbing the information written into the tube. The output signal may be observed on a monitor tube which is scanned with the reading beam.

—*Ibid*, July 1950, p. 740.

MATERIALS AND SUBSIDIARY TECHNIQUES:

Fluid matter is used to answer questions concerning the fields surrounding current carrying conductors. This is a method devised to give visible representations to magnetic or electrical fields.

—*Electrical Engineering* (U.S.A.), July 1950, p. 607.

Important improvements in the performance of military storage batteries, particularly at low temperatures has been in progress for some time, and information is given on lead-acid and nickel-cadmium batteries.

—*Ibid*, July 1950, p. 619.

Step-by-step instructions are given for potting electron tube assemblies in casting resin, including typical sources of the ingredients, and use of air-piston injector.

—*Electronics* (U.S.A.), July 1950, p. 101.

MATHEMATICS:

This edition of *Electronics* gives a number of important nomographs—vector computations—square root of a complex number—wavelengths of sound—filter design—resonant transmission lines—square wave response mixer frequency charts, to name only a few.

—*Electronics—Annual Buyers' Guide*, July 1950, p. R1.

MEASUREMENTS AND TEST GEAR:

Square-wave analysis is recognized as the fastest and most easily applied method for checking the response of amplifiers. The design is given of a 100 kc. square-wave amplifier generator producing waves of 10 volts peak to peak.

—*Radio and Television News* (U.S.A.), August 1950, p. 44.

The home-built 2 in. oscilloscope—detailed specifications on an interesting project for the experimenter, student, or technician who requires a simple and reliable instrument.

—*Ibid*, August, 1950, p. 65.

During recent years a need has grown for a vacuum-tube voltmeter whose indication depends only on rms values. The diotron circuit comprises a temperature-limited diode, D.C. amplifier and feedback path which solves a variety of electronic problems.

—*Electronics* (U.S.A.), July 1950, p. 93.

A kilomegacycle buzzer test oscillator—pulses of broad-band energy are injected into a tunable cavity at 800 cps, and output at any desired frequency between 3 and 11 kmc. can be selected. No tubes are used. A battery-driven buzzer on the doorbell principle provides audio-modulated signals in the band.

—*Ibid*, July 1950, p. 97.

MICROWAVE TECHNIQUES:

The paper covers certain wave-guide filters, each stage of which is composed of two identical inductive irises spaced so as to give match at the resonant frequency. Such filters have a low Q, giving wide band-width.

—*Proceedings of the I.R.E.* (U.S.A.), July 1950, p. 793.

Design relations for the wide-band wave-guide filter. Design formulae are presented graphically for the filter structure analyzed in a previous paper.

—*Ibid*, July 1950, p. 799.

Standing waves on R.F. cables—a continuation of the article in the earlier issue on the impedances of transmission lines. This also is a simplified article which deals with travelling waves and their interference with each other.

—*Wireless World* (Eng.), August 1950, p. 283.

PROPAGATION:

A description of the first installation of its kind of a nine-tower broadcast array which suppresses a total of 247 degrees of radiation. Day and night pattern change is accomplished by single push-button control of phasing.

—*Electronics* (U.S.A.), July 1950, p. 102.

RECEIVERS:

There is considerable advantage in audio limiting in c.w. reception, and the apparatus described protects the listener's ear from strong signals, key clicks, and divers other disturbances. It also cuts the operator's signal down to the same level without adjustment of the receiver.

—*QST* (U.S.A.), July 1950, p. 11.

TELEVISION:

Three years of experience by manufacturers and companies reveals 15 major reasons for servicing calls. Many can be eliminated by careful design and construction, often with savings in the manufacturing cost.

—*Electronics* (U.S.A.), July 1950, p. 66.

Television diplexers permit two or more radio-frequency signals to be transmitted simultaneously from one antenna without interaction of the signals generated. The balanced bridge and the slotted bridge type are mentioned.

—*Ibid*, July 1950, p. 74.

Circuits for sync. separation are not complex but their response to the composite signal is quite different from what a conventional sinusoidal analysis would show. The ideals and designs are discussed.

—*Ibid*, July 1950, p. 108.

It is now standard practice in television receivers to derive the e.h.t. supply for the cathode ray tube from the pulse developed in the scanning circuits during flyback. The major disadvantage lies in rather bad voltage regulation. The circuitry is explained.

—*Wireless World* (Eng.), August 1950, p. 279.

More uniform spot size over the face of the picture tube and improvement in quality is achieved by cosine-squared distribution of turns in the deflection. A permanent-magnet focusing assembly is also described.

—*Electronics* (U.S.A.), August 1950, p. 94.

"Contrast" may be defined as the intensity ratio between the whitest and blackest parts of a scene. Methods are discussed for minimizing ambient light, halation, reflection of back of picture light, hot spots, due to specular reflection from the curved tube, and laterally-directed picture light scattered by the phosphor itself.

—*Electronics* (U.S.A.), August, 1950, p. 111.

The many diverse applications of television outside the field of entertainment are unfamiliar to the average person. The vidicon tube is most useful for the observation of an event which is dangerous, inaccessible, or uncomfortable for the human being. The field of use for simple television sets for such circumstances is rapidly widening.

—*Electrical Engineering* (U.S.A.), July 1950, p. 624.

MISCELLANEOUS:

The electronic photoflash is now widely used but the servicing problems require consideration. The article lists the symptoms of trouble and the means of correcting it.

—*Radio and Television News* (U.S.A.), August 1950, p. 40.

A Special
MILES NELSON LTD.
Announcement

Two New Branches Opened

We have pleasure in announcing the opening of a branch at Wellington under the management of Mr. D. A. Taylor (Des), (phone 17-229), and a branch at Blackwell Motors Bldgs, cnr. Durham and Kilmore Sts., Christchurch, under the management of Mr. B. Blackwell (Bernie). We invite members of the trade to contact these two addresses for all radio and electrical supplies.

Invitation to visit our new modern warehouse in Surrey Crescent, Auckland.

Our new display rooms are designed along most modern lines and are unique. We cordially invite members of the trade to visit us at our new Auckland address in Surrey Crescent on the top floor of the Auckland Laundry building.

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- CHROMIUM PLATED
- RUSTLESS
- SPRING CONTACT BETWEEN SECTIONS
- PRECISION ENGINEERED

The "Walbar" telescopic car aerial is designed to fit any make of car and is available in a variety of lengths and models. Fitted with its specially insulated mounting to obtain maximum performance, the "Walbar" aerial will assure faultless radio reception whether your car is stationary or travelling.

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U.H.F. FREQUENCY STANDARDS

By the Engineering Department, Aerovox Corporation

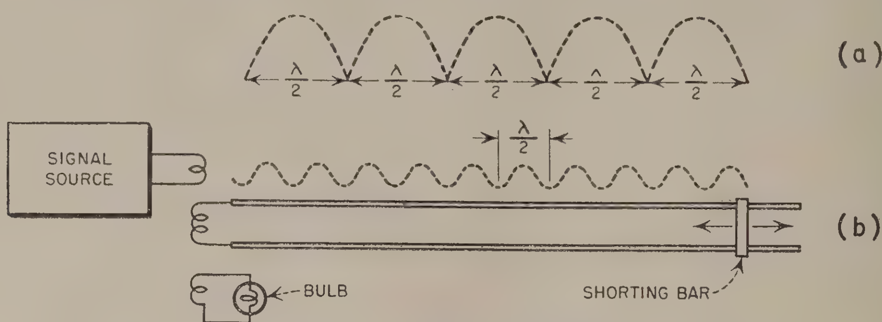
Accurate determination of the frequency of any cyclic phenomenon becomes increasingly difficult as that frequency departs further from the basic standard periodicity; the period of the earth's rotation. For this reason, the measurement of radio frequencies in the ultra high frequency range (300-3000 mc/sec.) necessitates the use of essentially new techniques—just as the original generation and transmission of such frequencies require methods which depart markedly from the conventional. Because of the increasing interest in this portion of the radio frequency spectrum, in connection with U.H.F. television, citizens radio, radar, microwave radio relay, and amateur communication, a review of these techniques is well justified.

At U.H.F., the usual primary standards employed at low frequencies are not conveniently applied. Signal frequencies derived from temperature-controlled crystal oscillators require an inconvenient number of multiplying stages to provide output in the U.H.F. region and the harmonic content of primary standards employing low-frequency multivibrators is usually insufficient to provide identifiable check-points at such frequencies. In addition, the propagation characteristics in this part of the radio spectrum do not make the use of standard-frequency broadcasting, such as WWV transmissions, practical. Other methods, such as the derivation of microwave primary frequency standards from the spectral absorption lines of gasses,[1] exist but are at present quite complicated and generally beyond the means of the individual experimenter or small laboratory.

PRIMARY-REFERRED STANDARDS

One method of referring a low-frequency primary standard signal to the U.H.F. region has been described in the *Aerovox Research Worker* for May, 1943. This system utilizes a succession of self-excited oscillators, each synchronized by the zero-beat method with the last useful harmonic of its neighbour. The lowest frequency oscillator in the series is synchronized with a primary standard such as WWV transmissions. Zero-beat or null indicators, consisting of meters or electronic tuning-eyes, are employed with each oscillator stage to give a ready indication of synchronism. Good stability is required of each oscillator in the chain if frequent readjustments are to be avoided. With sufficient care in operation, this system will yield U.H.F. check-points accurate to at least one part in one million.

Another simple system for obtaining U.H.F. check-points against a primary standard has been used.[2] This method produces usable harmonics throughout the lower portion of the U.H.F. spectrum and is capable of excellent accuracy. A conventional crystal-controlled oscillator circuit operating at 5 megacycles is supplied with *unfiltered* D.C. plate voltage. The harmonic content of the crystal oscillator output is greatly increased by the application of this pulsating D.C., with the result that marker frequencies occurring every 5 mc/sec. can be detected on a receiver throughout the 420 mc/sec. amateur band, the citizens' radio band, and the U.H.F. television band. An antenna cut for the desired output frequency serves to accentuate the harmonic output in that region. The 5 mc/sec crystal signal may be compared in a receiver with WWV transmissions on that frequency and may be zero-beat by variation of the crystal holder pressure, or by a small variable capacitance connected across the crystal. Since this method produces harmonics spaced at intervals equal to the crystal oscillator frequency, a secondary frequency standard, such as will be described later, must be used to identify harmonics.



TYPICAL LECHER WAVEMETER
FIG. 1

U.H.F. WAVEMETERS

Of considerably greater utility and convenience for the everyday measurement of ultra high frequencies are the standards based upon high quality resonant circuits. The U.H.F. predecessor of this family of frequency standards is the simple, well-known Lecher wire wavemeter. This instrument, used since the pioneering days of radio, is capable of high accuracy wavelength determination in the lower U.H.F. range, when judiciously used. For the purpose of comparison with the more modern systems to be discussed later, a brief description of the Lecher wavemeter will be included here.

The basic Lecher wire wavemeter is illustrated schematically in Fig. 1. It consists of a mechanically rigid length of parallel-wire transmission line, electrically coupled to the source of unknown frequency. Operation is based on the principle that the velocity of wave propagation along such an air-insulated transmission line is essentially equal to the velocity of light and hence the frequency of the source being measured is related to the lengths of the standing waves measured along its length by:

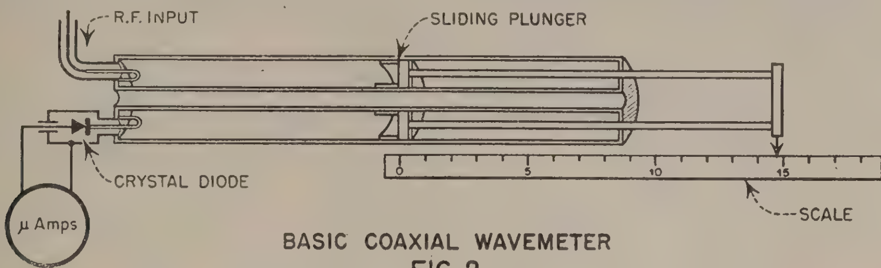
(1) $$f = \frac{30{,}000}{\lambda \text{ (cm.)}} \text{ megacycles}$$

Indication of the lengths of standing waves on a

Lecher wire is usually accomplished by sliding a short-circuiting bar along the transmission line and noting the positions at which the line is resonant at the unknown frequency. Resonance will occur at half-wavelength intervals and may be detected by its interaction with the circuit being measured or by an R.F. indicator such as a flashlight bulb or thermo-milliameter coupled to the Lecher circuit. The accuracy of the system depends upon the exactness with which the distance between points of resonance can be determined. Since these points correspond to R.F. voltage minima, they are usually quite sharp if losses are negligible. With considerable precision in construction and use, an accuracy of about 0.1 per cent. can be achieved with a Lecher wavemeter.

At the higher frequencies of the U.H.F. range, the accuracy of the simple Lecher wire system is limited by radiation losses, which lower the "Q" of the resonant circuit. This has the effect of introducing uncertainties in the positions of voltage minima, since these are no longer sharp as shown at (a) in Fig. 1, but are broader as illustrated at (b) for a lossy line.

These shortcomings of the standard open Lecher line have been overcome by the use of the *coxial* form of Lecher line shown in Fig. 2. Here the open, parallel-wire transmission line is replaced by a shielded coaxial line which is tuned by a sliding shorting plunger. The unknown frequency is coupled to the coaxial wavemeter by means of an inductive coupling loop and concentric cable. Resonance is indicated by interaction with the circuit being measured, or by a suitable R.F. indicator coupled to the wavemeter by a second coupling loop. This indicator usually takes the form of a crystal detector and microammeter. As in the basic Lecher system, wavelengths is determined by measuring the distance between resonance points which occur each half-wavelength. These points give maximum indications on the meter. Because of the fact that no radiation takes place from the coaxial circuit, very sharp resonances are obtained since the "Q" of the wavemeter can be made quite high, especially if the R.F. conducting surfaces are silver-plated and the coupling to the circuit is light.



BASIC COAXIAL WAVEMETER
FIG. 2

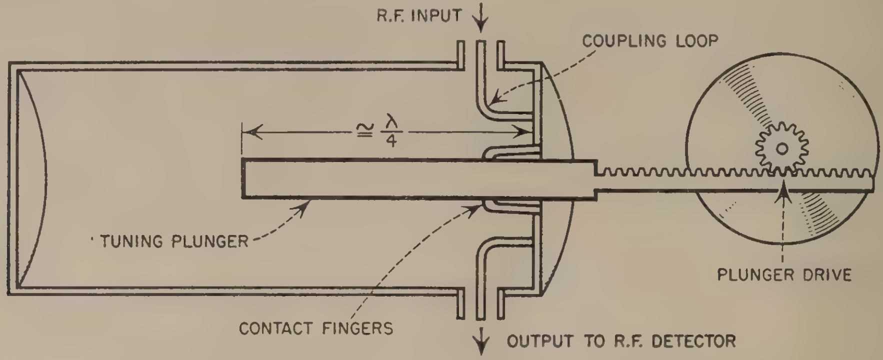
The accuracy of the coaxial wavemeter is determined by the precision of the mechanical drive mechanism which measures the position of the shortening plunger. In a high quality instrument of this type, the distance between half-wave resonance points can be determined to within about 0.001 centimetre. At 3000 mc/sec. this represents a realizable accuracy of 0.01 per cent. Wavemeters of the coaxial variety are widely used as U.H.F. standards since they are self-calibrating and are not greatly affected by temperature changes. The measuring accuracy of Lecher systems is increased if the line is long enough to permit the distance between several successive responses to be measured and averaged.

SECONDARY STANDARDS

Another form of coaxial wavemeter,[3] which makes a convenient secondary standard when calibrated by one of the foregoing systems, is depicted in Fig. 3. This type is called a *quarter-wavelength coaxial* wavemeter since it is resonant at the frequency for which the open-circuited centre conductor is an electrical quarter-wavelength long. This length may differ considerably from a physical quarter-wavelength because of foreshortening capacity between the outer conductor and the end of the inner conductor. However, the important characteristic of this type is the fact that the resonant wavelength is essentially a linear function of the centre conductor length. Therefore, if mechanical arrangements are made to vary the length of the centre conductor, the resonant wavelength will change four centimetres for each centimetre change in the length of the centre conductor. This 4 : 1 relationship is accurate within about 1 per cent. in a well-designed instrument. The curve of wavelength versus centre conductor length is thus linear and has a constant slope of 4. For this reason, the wavemeter may be calibrated roughly by comparison with a primary standard at a single check-point, as is illustrated for a hypothetical wavemeter in Fig. 4.

To avoid erratic readings, the centre conductor of a resonator of the quarter-wavelength type must make good electrical contact to the end plate. A set of spring contact-fingers may be used as in Fig. 3, or a special non-contacting choke joint is sometimes employed as a refinement. The centre conductor drive may be a rack-and-pinion arrangement for a "search" wavemeter in which extreme accuracy is secondary to wide tuning and convenience. For greater precision over a smaller range, a micrometer head drive is usually provided for the centre conductor.

At the lower frequencies in the U.H.F. range, wavemeters of the Lecher and quarter-wave coaxial types are somewhat bulky and inconvenient. For this reason, a capacity-tuned coaxial resonator as shown in Fig. 5, is sometimes preferable. This type is electrically similar



QUARTER WAVELENGTH COAXIAL WAVEMETER
FIG. 3

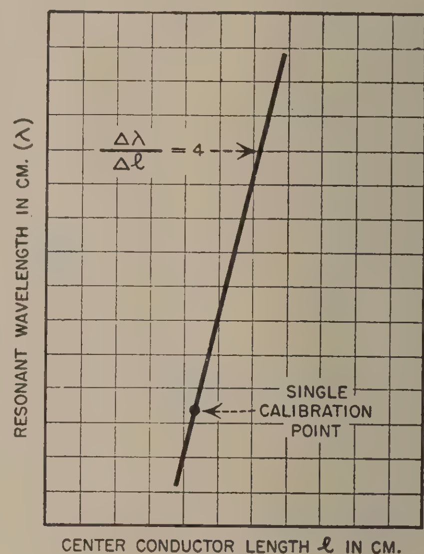


FIG. 4

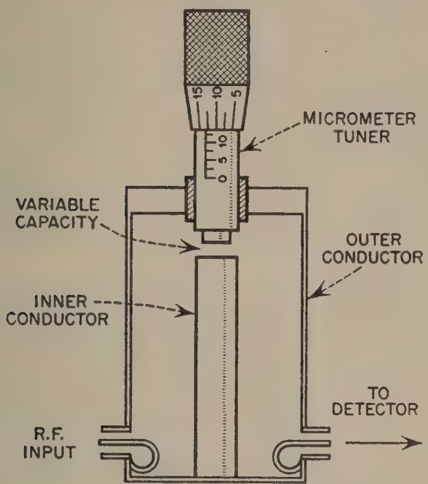
to the quarter-wavelength variety of Fig. 3, but is tuned by a variable capacitance at the end of the centre conductor, rather than by varying the centre conductor length. The tuning characteristic of this type is not linear, so that it must be carefully calibrated against another standard at a sufficient number of points to allow a curve of frequency (or wavelength) versus tuner setting to be plotted.

Although the "lumped" tuning capacity of this type of wavemeter makes it somewhat more compact than the types previously described, it is considerably more susceptible to errors due to thermal expansion. By careful design, this effect may be compensated in most wavemeters by the use of special low-expansion materials such as "Invar," or by making the outer conductor of a material having a temperature coefficient sufficiently greater than that of the centre conductor that capacitance changes due to expansion are corrected. An alternative

design,[4] makes use of a small temperature compensating fixed capacitor connected between the outer conductor and the end of the inner conductor.

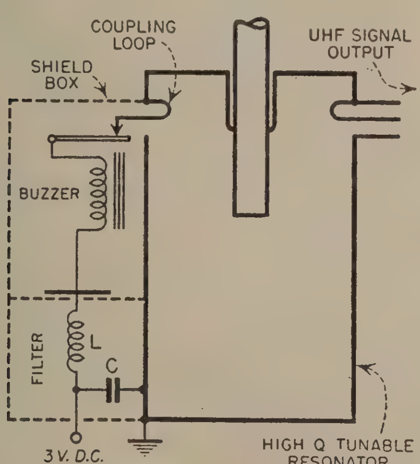
STANDARD SIGNAL GENERATORS

Calibrated signal sources for experimental work with U.H.F. receivers, antennas, and other components may be produced by utilizing high quality resonant circuits



CAPACITANCE TUNED COAXIAL WAVEMETER
FIG. 5

of the type described above for the frequency determining elements of self-excited oscillators. In general, the accuracy and stability of such devices is much inferior to that of the same circuits used as wavemeters because of the loading and thermal instability introduced by the vacuum tube.



BUZZER SIGNAL GENERATOR
FIG. 6

An important exception is the *buzzer signal generator*[5] shown in Fig. 6. In this extremely simple and useful device a high "Q" cavity wavemeter, usually of the quarter-wavelength type, is excited by the noise "hash" generated by the interrupter contacts of a buzzer. The wavemeter circuit acts as a very selective band-passfilter which passes only the frequency component to which it is tuned. Since the short pulses generated by the buzzer are very rich in high frequency content, the signal generator will provide useful output throughout the entire tuning range of the resonant cavity circuit. The output signal is tone modulated at the buzzer frequency. To prevent spurious radiation, the buzzer and its D.C. leads must be well shielded and filtered. The frequency stability and accuracy of the buzzer signal generator is essentially equal to that of the wavemeter circuit since no vacuum tube is used to contribute electronic loading and little heat is generated. Such devices have been used as standard signal sources to at least 10,000 mc/sec.

REFERENCES

1—Electronics, April 1949.
2—Radio and Television News, January 1950.
3—Electronics, March 1948.
4—Electronics, September 1949.
5—Electronics, July 1950.

OUR GOSSIP COLUMN

THE NEECO BALL

Three hundred and fifty happy people celebrated Neeco Night at Wellington's Majestic Cabaret on Thursday, 21st September—and once again the evening has been voted an outstanding success.

This annual event has become a trade highlight, and each year more and more friends of the company put in an appearance and join in the fun. A first-class floor show is always a part of the National Electric programme, and this year's was well up to past presentations.

A raffle in aid of the Kaiwarra factory children's Christmas party brought excellent results, and the fund benefited to the tune of almost £10.

By design this year's Ball coincided with the Conference of Branch Executives and the accompanying photograph brings together the managers of the four main centres—who seem to be having a very pleasant evening off. Reading from left are D. H. Shortt, Dunedin; R. S. Donovan, Wellington; E. N. Tewsley, Auckland; J. Cunningham,. Christchurch.

* * *

Recent Auckland visitors to Wellington included B. Peoples, H. Barr, B. Blackwell, J. Brackenridge, T. Woods, and T. Bates.

* * *

Doug. Gorman, well known in "ham" circles, has joined the staff of Standard Telephones and Cables Ltd., Wellington, as purchasing officer for factory requirements.

* * *

Production in Auckland is booming, judging by recent births—Bernard Willis has a baby girl; Herb. Wilson has followed suit, and Jack Kirk has another daughter. Not content wtih that, Jack had to produce a bull calf on his "hobby" farm. What with this and ducks and hens, Jack says its one cackle after another.

* * *

Autocrat members diverge in their several spare time enjoyments. Geo. Benson, sporting an 18ft. outboard launch, expects to land the biggest schnapper of the season. Ray Walker is fond of fishing, too, but says he will not risk the launch, even with Commodore Benson, whilst Bernard says that his new offspring will suit him for hobby this season.

Some interesting exhibits of plastics were shown to our R. & E. representative, by Clearlite Ltd. at Auckland during a recent visit to that city. New designs for radio cabinets and a variety of utility lines showed promise for the future plastic enthusiast.

* * *

Bill Barker, when interviewed in Auckland, had an optimistic outlook and says "Sound Systems" is his keynote for the future.

* * *

L. Rhodes, of Radio Repairs Ltd., Auckland, seen in his little red truck, is working like two men on the "Great White Way" proposition. Anyone looking for real work in the Queen City should contact "Dusty."

* * *

Although time did not present the opportunity for inspection, we hear that National Electrical Co., Auckland, have just installed the latest of paging systems.

Jack Nicholson has been spending a week or so in Australia. He will be back in time to appreciate the completion of his new premises.

* * *

Johnnie Bull, seen in Auckland, looks fit and says he has plenty of room to move around in the new premises at Surrey Crescent and plans are under way for further extensions.

* * *

Visiting Sydney and Melbourne is J. A. Holmes, Chief Factory Executive of Radio (1936).

* * *

Believing in nothing but the best housing for the high-priced speakers, Radio Repairs has produced an ornate baffle for the discriminating buyer.

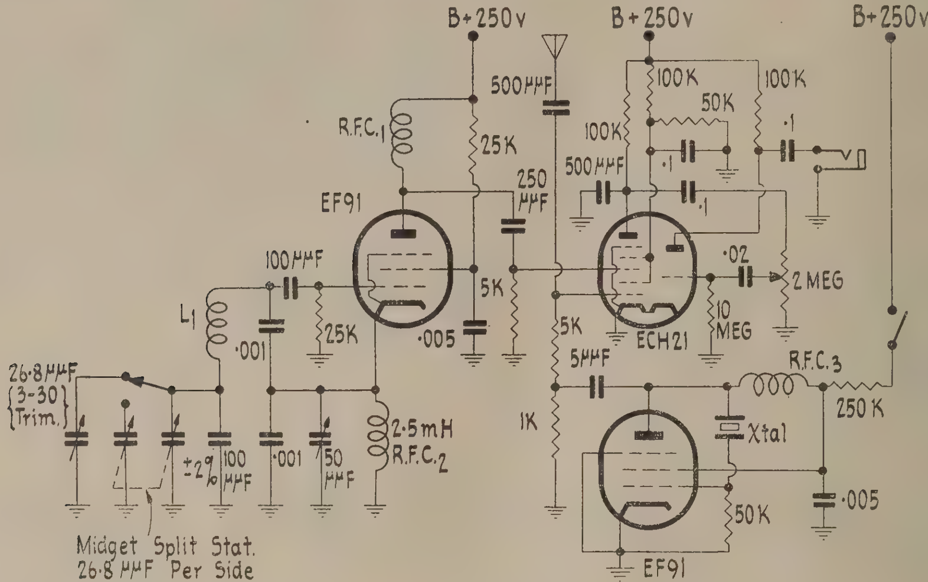
* * *

Miles Nelson Ltd. have removed from Chancery Lane to up-to-date premises at Surrey Crescent.

The PHILIPS Experimenter

An Advertisement of Philips Electrical Industries of N.Z. Ltd.

No. 37: An Accurate Beat Frequency Meter for the H.F. Amateur Bands



INTRODUCTION

We have often been asked by readers of the Experimenter to provide them with the design for a good beat-frequency meter which will enable frequency checks to be made with an accuracy that will enable the most stringent requirements of the Post and Telegraph Department to be met, and it is only after considerable thought that the instrument to be described was evolved. Basically, of course, the beat-frequency meter, of whatever detailed design, consists of an oscillator and a detector. The oscillator's frequency may be varied, and it has an accurate calibration so that when the signal whose frequency is to be measured is brought to zero beat by adjusting the oscillator, the answer is read from the calibration of the oscillator. Such an instrument is not restricted to operation on the fundamentals of either the signal source or the internal oscillator, so that, even with a single tuning range for the latter, a very wide frequency band is made available for use in measuring. If the variable oscillator has a range of at least 2:1 in frequency, then the signals that can be measured lie, theoretically at least, within a band extending from the low-frequency end of the oscillator's range to a frequency limited only by our ability to detect and recognize the harmonics of the oscillator.

In practice, a frequency range of at least 10 to 1 can be covered in this way, and if special care is taken, there is no reason why the instrument cannot be used at frequencies lower than the lowest oscillator frequency by making use of the harmonics of the signal source itself to beat with the fundamental of the oscillator. It can thus be appreciated what a versatile instrument the beat-frequency meter is, and that its accuracy depends solely on the accuracy with which the variable oscillator can be calibrated. During the late war, a portable meter of this type was designed and built in huge quantities, and many amateurs have been able to buy them through war disposals. This particular meter is perhaps the most accurate portable frequency meter ever made, and had a guaranteed accuracy of 0.01 per cent. It is not so long since this order of precision would have constituted a secondary frequency standard!

It is not suggested that this order of performance will be obtained in any home-built equipment, but there is no reason why accuracies of better than 0.1 per cent. should not be obtained if care is exercised in the mechanical and electrical construction. The general arrangement of the circuit has been patterned on that of the frequency meter referred to above, but there are considerable differences in detail, owing primarily to the fact that the present instrument is designed for use on amateur bands. We would like to point out that the results obtained in the finished article will depend as much on the excellence of the mechanical construction as on the suitability of the circuit. Indeed, it is a moot point whether the one is more important than the other. It is certainly true that the whole job should be considered as a precision instrument, and built accordingly, if anything like its full capabilities are to be realized.

CIRCUIT DETAILS

The meter consists of two oscillators, each using an EF91 miniature high-slope pentode, and an ECH21, the heptode section of which is used as a detector and the triode section as an audio amplifier. One oscillator is the variable-frequency one, described above, while the other is a crystal oscillator on 1000 kc/sec. So far, the function of this second oscillator has not been mentioned, but it is an extremely valuable addition to the circuit. It enables certain spot frequencies on the useful range to be very accurately set up by beating the variable oscillator with the crystal one. The latter then forms a perpetual check on the calibration of the variable oscillator, and its use means that the long-term accuracy of the device as a whole is very much better than if the calibration were done once for all, and then left. Calibration checking is a tedious business, ordinarily, and unless one has some sort of a standard to work with is entirely impossible. The crystal constitutes a built-in standard which itself can be checked at intervals against standard frequency transmissions such as those of WWV. The frequencies at which beats can be heard between the two oscillators, and their harmonics can be readily predicted and recognized, and at these points, known as *check points*, the variable oscillator can be set to zero beat, which means that the short-term stability is of the same order as that of the crystal oscillator itself at these frequencies.

Furthermore, if the device is well constructed, the accuracy need not deteriorate much, even at frequencies in between check points. This feature, however, is dependent on the accuracy with which the dial of the variable oscillator can be set and read. It is imperative, therefore, to have as good a dial and drive mechanism for the variable oscillator as can be found. A good vernier dial can be read to three places of decimals, and can be set to a given position more accurately than it can be read. For the original model, illustrations of which will be featured in the next instalment of this article, a National Type N dial is used, and this admirably fulfils the requirements. Of course, if anything better can be found, it can usefully be put to work. Dials have been made that can be read to four places of decimals, but it is doubtful whether the rest of the equipment could be made worthy of such a mechanism without a manufacturer's facilities. However, the moral is to use as good a dial as can be obtained, with the National N as a suitable type.

Since this is designed as an amateur instrument, it was decided that considerable advantage would accrue if the variable oscillator were bandspread. One very attractive feature of this is that it enables the Clapp oscillator circuit to be used, with very beneficial effects on the stability of the oscillator. One defect of the Clapp circuit is that it is difficult to make work satisfactorily

(Continued on Page 43.)

The "R. and E." Senior Communications Receiver

PART III

THE 100 KC/SEC. CIRCUIT

V_4 is an oscillator-mixer valve, whose purpose is to convert the 455 kc/sec I.F. to 100 kc/sec. Its circuit is quite ordinary, and requires little in the way of special comment. V_4 is an X61M, which is a modern triode-hexode of high gain and excellent frequency stability. Its signal grid is fed from the same point on the circuit as the grid of V_2. This gives a useful degree of 455 kc/sec. selectivity before the conversion takes place, and this ensures that signals far removed from the centre intermediate frequency have been well attenuated before being applied to the 455 to 100 converter. The point is of some importance when it is remembered that as with all converters, the 100 kc/sec. one can respond to its own image frequency. For instance, the oscillator section of V_4 is tuned to 355 kc/sec, so that with the 455 kc/sec. signal, a beat is obtained at 100 kc/sec. But in addition, a 255 kc/sec. signal, were it present could beat with the 355 kc/sec. oscillator to produce output at 100 kc/sec. With, say, only one tuned circuit at 455 kc/sec., it might be possible for a very strong signal on 255 kc/sec. to cause trouble, but with three circuits at the higher I.F., this is virtually impossible.

The oscillator section of V_4 has a small trimmer condenser C_5 connected across the tuning coil and brought out to the front panel. This control is extremely useful, and acts as a fine tuning control, giving only about 10 kc/sec. shift in the oscillator frequency on either side of the official 355 kc/sec. Its purpose was described in the first instalment of this article, and we will have more to say about its actual use when we come to describe the alignment and operation of the set.

It was mentioned earlier, too, that a rather special circuit was used in the 100 kc/sec. amplifier chain, which gives continuously variable selectivity up to almost crystal sharpness, and we now come to this part of the circuit. The output of V_4 is via a double-tuned 100 kc/sec. I.F. transformer in the ordinary way. The secondary of this transformer is directly connected to the grid of V_5, the first 100 kc/sec. amplifier valve. It will be noted that there are no tuned circuits between V_5 and V_6, which are resistance-capacity coupled, but that the output of V_6 is coupled to the detector V_7 through a second transformer, shunt fed from the plate of V_6. V_5 and V_6 are 6SG7s, which have high mutual conductance, and which therefore have high gain when connected as resistance-coupled amplifiers, even at frequencies as high as 100 kc/sec. The cathode resistor of V_5 is unbypassed, which reduces the gain of the first valve somewhat. This is not the object of the omission of the bypass condenser, as we shall see shortly, but the loss of gain can well be afforded. If C_{11}, R_{11}, and R_{10} are omitted from the circuit, it can be seen that there is nothing unusual about the circuit containing V_5 and V_6. The resistance-capacity coupling is perfectly straightforward, screen dropping resistors being used in the ordinary way. Since low-frequency response is not needed, the coupling condenser C_9 is made quite small, and the screen bypass condensers C_8 and C_{14} do not have to be made very large. The plate load resistor of V_6 has been made a potentiometer, from whose moving contact two feedback voltages are picked off. C_{11} is merely a blocking condenser to prevent the D.C. plate voltage from appearing in the feedback circuit. Let us suppose for a moment that the slider of R_{12} is at the plate end of its travel. R_{10} then acts as a voltage divider together with the unbypassed cathode resistor R_9, and

COMPONENT LIST

R_1, R_{24}, R_{30}, R_{39}, 2k.
R_2, 15k.
R_3, R_{18}, 10k.
R_4, R_{20}, R_{21}, R_{34}, R_{35}, 1 meg.
R_5, R_{23}, R_{38}, R_{40}, R_{43}, R_{44}, R_{45}, R_{46}, 50k.
R_6, R_{14}, R_{17}, R_{22}, R_{25}, R_{37}, 100k.
R_7, R_{10}, 25k.
R_8, 2500 ohms.
R_9, 1000 ohms.
R_{11}, 10.5 megs. approx. (See text.)
R_{12}, 25k. w-w pot.
R_{13}, R_{16}, R_{28}, R_{29}, 500k.
R_{15}, 300 ohms.
R_{19}, R_{32}, R_{33}, 250k.
R_{26}, 800 ohms.
R_{27}, 250 ohms.
R_{31}, 80k.
R_{36}, 500k. pot.
R_{41}, 5k. w-w pot.
R_{42}, 50 ohms.
R_{47}, 50k. pot.
R_{48}, 3k.

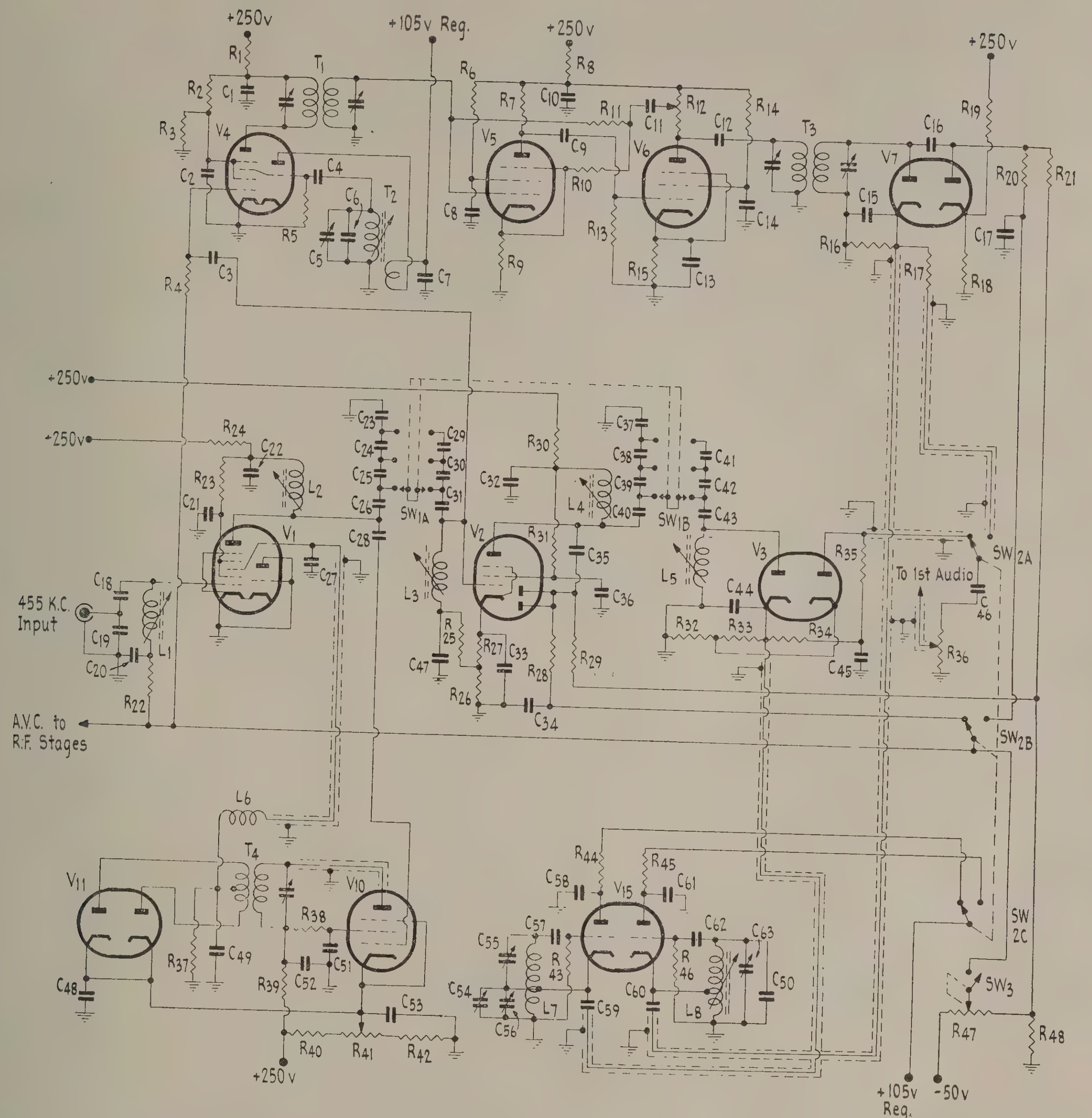
C_1, C_2, C_8, C_{13}, C_{14}, C_{20}, C_{22}, C_{32}, C_{36}, C_{48}, C_{52}, C_{53}, 0.1 μf.
C_3, C_{27}, C_{28}, C_{35}, C_{57}, C_{62}, 50 $\mu\mu$f. mica.
C_4, C_{15}, C_{16}, C_{44}, C_{59}, 100$\mu\mu$f. mica.
C_5, 17 $\mu\mu$f. max. variable.
C_6, C_{50}, in coil assembly.
C_7, C_9, C_{34}, C_{46}, C_{58}, 0.01 μf.
C_{10}, 0.25 μf.
C_{11}, 0.002 mica.
C_{12}, 15$\mu\mu$f. ceramic.
C_{17}, 0.5 μf.
C_{18}, C_{26}, C_{31}, C_{40}, C_{43}, 100 $\mu\mu$f. silvered mica (in coil assemblies).
C_{19}, 0.001 μf.
C_{20}, C_{33}, C_{47}, C_{51}, C_{61}, 0.05 μf.
C_{23}, C_{37}, see text.
C_{24}, C_{29}, C_{38}, C_{41}, see text.
C_{25}, C_{30}, C_{39}, C_{42}, see text.
C_{45}, 0.05 μf.
C_{49}, C_{60}, 500 $\mu\mu$f.
C_{54}, C_{63}, 75 $\mu\mu$f. max. variable.
C_{55}, C_{56}, B.F.O. trimmers.

V_1, ECH21.
V_2, 6AR7-GT.
V_3, V_7, V_{11}, 6H6.
V_4, X61M.
V_5, V_6, 6SG7.
V_{10}, 6BA6.
V_{15}, 6SN7-GT.

Sw_1 (A and B) 455 kc/sec. sel. switch.
Sw_2 (A to C) 455 to 100 kc/sec. changeover.
Sw_3, A.V.C.-manual changeover.

L_{1-5}, single 455 kc/sec. coils in cans, permeability tuned.
L_6, 10 mH. R.F. choke.
L_7, and L_8, B.F.O. coils in cans, 455 and 100 kc/sec. respectively.

T_1, T_3, 100 kc/sec. I.F. transformers.
T_2, 355 kc/sec. oscillator coil.
T_4, 455 kc/sec. Xtal filter input transformer, used as noise rectifier transformer.



applies a fraction of the output voltage to the cathode of V_5. Since the feedback is applied over two stages back to the cathode of the first, this feedback is negative, and because the feedback network contains only resistors, this negative feedback is effective at all frequencies. It reduces the gain of the two-stage amplifier to approximately one-eighth of the gain without feedback.

Now as well as the negative feedback already described, there is a second feedback path from the plate of V_6 back to the grid of V_5. This feedback is obviously *positive,* and its amount can be regulated by varying the value of R_{11}, just as the amount of negative feedback could be regulated by altering R_{10}. From the grid of V_5 to earth, however, there is the secondary of the I.F. transformer T_1. Now at resonance, a tuned circuit has the same characteristics as a resistor of very high value. Thus, at 100 kc/sec., to which the circuit is tuned, R_{11} forms a resistive voltage divider with the tuned circuit. Now it is well known that the impedance of a parallel-tuned circuit is greatest at resonance, and becomes less and less at frequencies further and further removed from the resonant one. Thus, the amount of positive feedback is greatest at the frequency to which the secondary of T_1 is tuned, because at this frequency, the impedance of the transformer tuned secondary is greatest, and thus more signal voltage is fed back than at any other frequency.

If R_{11} is carefully adjusted, it is possible for the

positive feedback through R_{11} at resonance, to balance exactly the negative feedback through R_{10}. Thus, at resonance, the amplifier has the same voltage gain as if no feedback were present at all. At frequencies off resonance, however, the amount of positive feedback becomes progressively less as we go further from the tuned frequency; the amount of negative feedback, on the other hand, remains constant, because this does not depend on the characteristics of the tuned circuit. Therefore at frequencies away from resonance, there is a net negative feedback, and this residual negative feedback is greater the farther away we are from the resonant frequency. We therefore have (*a*) the attenuation due to the selectivity of the tuned circuit itself, which is unaffected by the feedback, and (*b*) additional attenuation, due to the net negative feedback at frequencies away from resonance. The attenuation (*b*) is added to the normal selectivity of the circuit, so that extra-high selectivity is obtained. Now this method of gaining high selectivity has several advantages not possessed by the usual method, which is simply to add more and more tuned circuits until the desired selectivity is reached. In the first place, it is cheaper, since each additional transformer means an extra amplifier stage. This is required only as an isolator, as one stage can give all the amplification that may be needed, so that in comparison, adding extra amplifier stages to gain selectivity is a very uneconomical method.

Secondly, it is probably easier to put into effect, because a number of amplifier stages is increasingly difficult to stabilize on account of the very high overall gain involved. Here, however, there are only the two stages, and although comprehensive precautions must be taken against instability, it has been found that stability is exceedingly good, with no sign of regeneration, let alone oscillation.

Lastly, and perhaps most important, the present method gives us a very elegant method of varying the selectivity actually obtained, at the turn of a potentiometer. *This is something that no other system of obtaining high selectivity can provide*. Moreover, when the selectivity control is adjusted, *there is absolutely no change in the amplification at resonance*. This again is a feature that no other scheme can give us. How, then, does the variable selectivity work? Simply by simultaneously controlling the amount of the negative and positive feedbacks. This is done by taking both feedbacks from the moving arm of R_{12}, and a little thought will show that the features mentioned above arise automatically when this is done. It will be remembered that the value of R_{11} was chosen so that the positive feedback balanced the negative feedback. Thus, the gain at resonance is the same as without feedback at all. Now, if the slider of R_{12} is moved, towards the H.T. line, the portion of output fed back through back chains becomes less, but because both feedbacks still come from the same point on the circuit, they still balance, and the gain at resonance still remains unchanged. When the slider of R_{12} is at the H.T. line, there is no feedback whatever, and the gain is still unchanged. But when the slider is moved, the amount of negative feedback (independent of frequency, it will be remembered) is reduced, so that off resonance, the net negative feedback is reduced too; this means that the additional selectivity due to the feedback arrangements becomes less as the slider is moved, although the overall gain remains unchanged. Finally, when there is no feedback, the selectivity is simply that due to the tuned circuit alone.

The following transformer T_3 has no effect on the variable selectivity action, and all that it does is to add to the total selectivity of the system. Thus, when the potentiometer is in the broad position, the selectivity is that due to two normal 100 kc/sec. I.F. transformers, and this is augmented progressively as the control is advanced.

The 100 kc/sec. second detector and A.V.C. rectifier functions are fulfilled by V_7, which is a 6H6. The output of the detector goes to the volume control, R_{36}, via the appropriate section of the 455/100 change-over switch, Sw_{2a}. The wiring run here is rather long, and since shielded wire is advisable, use is made of its rather high capacity as part of an R.F. filter, which prevents the residual 100 kc/sec. in the detector output from being applied to the audio amplifier. When the I.F. is very low, like this, it is harder than usual to keep it out of the audio amplifier, because the latter amplifies it better than it does, say 455 kc/sec. It is well known that some sets are quite unstable, simply because I.F. is allowed to get into the audio stages, where it is amplified, and appears at the output stage as an I.F. signal of high amplitude. There it is radiated to the rest of the set wiring, and causes quite uncontrollable oscillation of the I.F. channel.

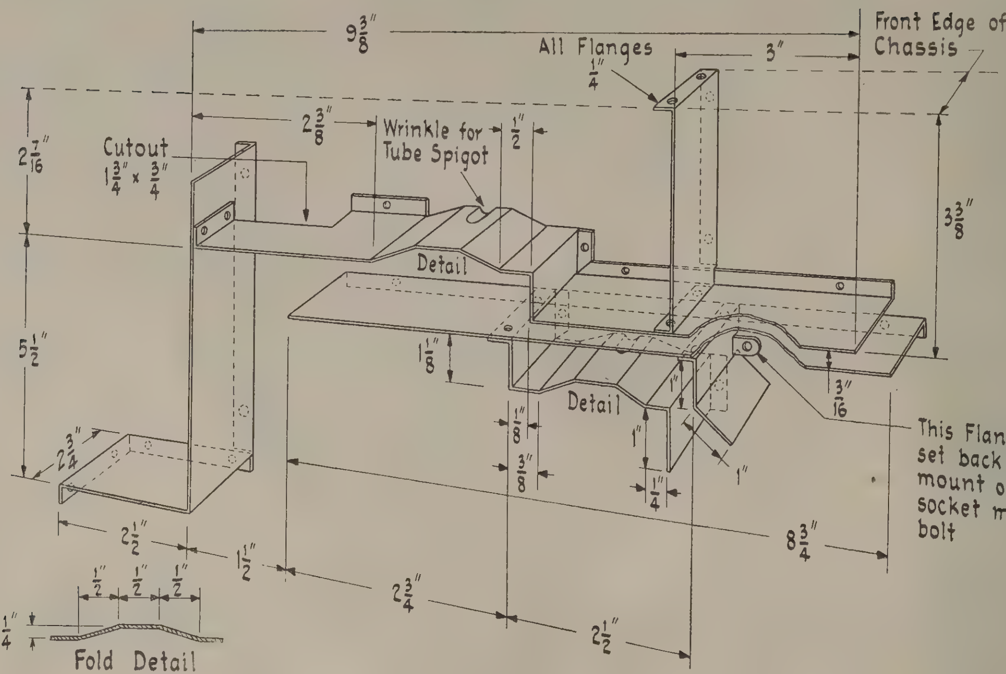
THE BEAT OSCILLATORS

Since we have two independent I.F. channels in this set, and can switch very rapidly from one to the other by working Sw_2, it is desirable to have two beat oscillators for code reception, even though only one I.F. channel is specifically designed for C.W. reception. If we have a B.F.O. on the 455 kc/sec. I.F. channel, too, we are enabled to use this, with its relatively wide pass band, for searching purposes. This enables a far readier estimate to be made of the number of C.W. signals on the band that we might be interested in and frequently, in any case, conditions will be such that it is not necessary to switch to the 100 kc/sec. channel in order to receive the station we want. If a B.F.O. were provided only for the 100 kc/sec. channel, all C.W. reception would have to be done on this band. Again, it is frequently an advantage to turn on the B.F.O. even when we are searching for 'phone stations, since it enables a carrier to be heard even through considerable noise and C.W. interference. Even though the carrier may be too weak to copy, its presence can be noted, and a check on its strength can be kept, to see if it seems likely to come up to a suitable strength for working. This is a definite help in D.X. working, and when one is searching a band such as "ten," waiting for it to open up.

As well as the above advantages, the possession of a B.F.O. on both channels enables one to identify a station on the 455 kc/sec. channel, and then switch to the selective 100 kc/sec. one, when the 100 kc/sec. B.F.O. is set correctly. Then, should the signal drift off the extremely sharp 100 kc/sec. response peak, or the main tuning dial be accidentally moved, a quick switch to the 455 channel will enable the signal to be found once more.

For the B.F.O.s, V_{15}, a 6SN7-GT is used, as two separate valves. Each section is quite independent of the other, as can be seen by a glance at the diagram. The left hand section is the 455 kc/sec. B.F.O., and its output is fed to the cathode of the 455 detector. Commercial B.F.O. coils are used, and these are both arranged to be used as cathode-tap Hartley oscillators. The switching is done in the H.T. line, by Sw_{2c}. The decoupling filters, R_{14}, C_{58}, and R_{15}, C_{61}, are used both to ground the plates of the oscillator valves effectively, but also to act as voltage droppers, which by controlling the H.T. voltage on the oscillators, also control their outputs and set them at a suitable value for their respective channels.

In the circuit diagram's caption, in the previous instalment of this article, the units of V_{15} were wrongly



The above is a dimensioned sketch of the underneath shielding required for the Senior Communications Receiver. It is made from light aluminium sheet, so that it is not difficult to construct, and yet the corners and bends result in a stable and rigid structure when it is screwed to the chassis.

labelled; and the left-hand half and its associated circuit is the 455 kc/sec. oscillator, not as was stated, the 100 kc/sec. one.

MANUAL GAIN CONTROL

In order that either channel can be used with the A.V.C. inoperative if desired, a manual gain control has been provided, R_{47} on the circuit diagram. This potentiometer has a single-pole on/off switch associated with it, Sw_3 in the diagram. It will be seen that the A.V.C. line, which constitutes the grid return for all controlled stages, is connected both to Sw_{2h} and to Sw_3. Whether the latter is open or closed, the A.V.C. line is connected to one or other of the A.V.C. rectifiers, so that whether the manual control is connected or not, any A.V.C. voltage that is developed by the rectifier in circuit at the time, is applied to the controlled stages. But R_{47} is not very high in value—only 50k.—so that if Sw_3 is closed, this resistance forms with the A.V.C. filter resistor a voltage divider which causes a drastic reduction in the A.V.C. voltage actually applied to the line. For example, with the Sw_2 in the position shown in the diagram, the 455 kc/sec. channel is in use. Thus, the controlled stages are supplied with bias from the diodes of V_2, through the filter resistor R_{28}. This has a value of 500k., so that when Sw_3 is closed, and R_{47} is set at minimum gain, the most A.V.C. voltage that can be applied to the A.V.C. line is one-eleventh of the total developed by the rectifier. But this is likely to be very much less than the 50 volts that is applied to the A.V.C. line by the potentiometer R_{47} when it is in this position, so that although the A.V.C. rectifier can still work, it is ineffective as far as controlling the gain is concerned. Now, when the gain is increased by moving the tap of R_{47} towards earth, thus decreasing the negative bias on the controlled stages, it might be supposed that more output would be developed by the A.V.C. diode, and this would now become effective. But in practice, this does not happen. More rectified voltage is certainly developed by the A.V.C. diode, but since R_{47} has been moved down towards earth, the portion between the tap and earth is now of smaller resistance, so that a smaller fraction of the A.V.C. voltage is applied to the line, and the A.V.C. is still ineffective. Thus, is can be seen that there is no need to disconnect the A.V.C. rectifier from the circuit. The shunting of R_{47} sees to it that when the manual control is in use, the A.V.C. cannot affect the gain of the set.

It will be noticed also that the plates of both A.V.C. rectifiers are connected to R_{48}, though not directly. In the case of V_2 we have R_{29} between the diode plate and the junction of R_{47} and R_{48}. The latter point is at a potential of approximately —3 volts with respect to earth, so that through R_{29}, this potential is applied to the diode plate. Under conditions where no signal is being received, there will be no output from the A.V.C. rectifier, but since R_{29} is connected to the A.V.C. line through R_{28}, the —3 volts from the top end of R_{48} is applied to the controlled tubes. V_1 is one of these, and it will be noticed that its cathode is directly earthed. This connection therefore supplies the tubes connected to the A.V.C. line with a minimum bias voltage of —3 volts. The resistor R_{29} is actually the load resistor of the A.V.C. diode, and similarly, in the other channel, R_{21} is the load resistor for the A.V.C. diode of V_7. Thus, whichever channel is selected, there is always a minimum bias of —3 volts for the controlled tubes. Where delayed A.V.C. is used, normal practice is to supply the required minimum bias individually for each tube by cathode biasing. However, there are good arguments in favour of earthing the cathodes directly. Apart fom saving components, it makes it much easier to obtain stable amplifier operation in a multi-valve set. Constructors should note that with this system of biasing, it will be essential to earth

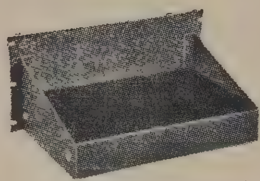
directly the cathodes of all valves in the tuner that are to be gain-controlled. Thus, if an existing tuner is to be used, it may be necessary to remove or short-circuit the cathode bias resistors, if these are employed. Although this scheme seems complex, it has several advantages, not the least being that some rather complicated switching in the cathode return circuits of the controlled valves is avoided. This is very desirable in the present case, since the issue would be still further complicated by the switching between the two channels. The present scheme enables a single manual gain control to be effective on both channels, thereby reducing the already rather alarming number of controls, and simplifying the circuit considerably.

It can be seen that the minimum bias is controlled solely by the value of R_{48}, and also that the A.V.C. delay voltages can both be adjusted quite independently of the minimum bias.

In the next instalment of this article we will present photographs and chassis diagrams showing the special baffle-shielding that has to be built underneath the chassis before the bulk of the wiring can be proceeded with. The underneath shielding is concerned mainly with the 100 kc/sec. amplifier chain, since almost absolute amplifier stability is essential here, in view of the fact that both positive and negative feedback is used intentionally. The slightest degree of unintentional positive feedback can make the system quite unworkable, and while this might make it appear that the constructional difficulties will be great, this will not be so as long as the construction is carried out in exact accordance with the original. The under-shielding is made of fairly thin aluminium sheet, which it quite rigid enough on account of the type of construction used, and yet is easy to work.

(To be continued.)

★CHASSIS ★CABINETS ★RACKS



Panel and Chassis Combinations

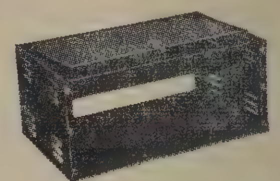
CHASSIS AND PANEL COMBINATIONS

Chassis size	17 in. x 10 in. x 3 in.	37/6
Chassis only	17 in. x 10 in. x 3 in.	18/–
,, ,,	15 in. x 9 in. x 3 in.	16/–
,, ,,	12 in. x 8 in. x 2½ in.	14/–
,, ,,	9 in. x 7 in. x 2½ in.	10/6

CABINETS

To take chassis	Round End	Square End
17 in. x 10 in. x 3 in.	£3 10 0	£3 4 6
15 in. x 9 in. x 3 in.	£3 5 0	£2 19 6
12 in. x 8 in. x 2½ in.	£2 15 0	£2 10 0
9 in. x 7 in. x 2½ in.	£2 5 0	£2 0 0

Postage Included.



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CALVERTS LIMITED 138 TUAM STREET, CHRISTCHURCH

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INSULATED RESISTORS

Cut Costs

Radio and Electrical Engineers know that I.R.C. offers the most complete line of resistance products in the industry . . . a fixed or variable resistor for almost every requirement . . . with uniform dependability proved by years of rigorous laboratory and field tests.

• BETTER ENGINEERING DESIGNS • FEWER SERVICE CALLS • HUMIDITY PROOFED, for longer life • FEWER STOCK SIZES REQUIRED, less paper work • QUICKER ASSEMBLY, less testing.

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THE NEW ZEALAND ELECTRONICS INSTITUTE (Inc.) NEWSLETTER

HEADQUARTERS NEWS

At the monthly Council meeting held recently a considerable volume of business was transacted at headquarters, including the following items:

Institute Insignia: Council has had under consideration for some time the adoption of an electronic emblem as the official insignia of the Institute to be used on official stationery and other such documents. Considerable progress was achieved at this meeting and it is anticipated that finality will be reached at the next meeting of the Council, and an emblem agreed upon.

Admissions Committee: The undermentioned applications were approved in the status as detailed:

Associate Members: Mr. F. W. Cropley, 6 Mariri Road, Kelburn, and Mr. K. J. Salmon, 56 Rotherham Terrace, Miramar. To the above Associate Members, Council and Wellington Branch would extend a cordial welcome.

Tape Recording: Considerable discussion ensued in connection with tape recording and its application to the Institute work. It was felt that it would be possible to obtain a recording of outstanding addresses delivered to branches of the Institute in the Dominion and then redistribute the record in order that all members can then have the benefit of hearing particularly interesting talks. There would be certain technical difficulties involved but arrangements were left in the hands of a sub-committee to further investigate the matter and report back at a later date.

Increase in Membership: In order to advise potential members more fully of the functions of the Institute, it was agreed that a brochure should be prepared and distributed throughout New Zealand. A proposed publication was tabled and approved for distribution to branch committees for opinions.

Membership Certificates: Following on a request from a branch that the Institute should distribute Certificates to all members it was felt that a small proportion of members might terminate their membership on account of the increased rate of subscriptions and consequent difficulty would be experienced in obtaining the return for any certificates issued, particularly if members concerned proceeded overseas. Under these circumstances Council agreed to continue the policy of issuing Certificates only to financial members and that the attention of all those associated with the Institute be drawn to Section 10 (c) of the Institute Constitution which states that Certificates remain the property of the Institute.

BRANCH NEWS

Christchurch: During September, members of Christchurch Branch were privileged to hear a talk by Mr. Gardner on "Ionospheric Recording Methods." The speaker opened with a brief survey of methods used up to 1939. The development of the latest equipment was then traced through various stages, up to the latest device which, with the aid of a long-afterglow cathode ray tube and photo attachment, permitted continual visual records of ionospheric activity to be obtained. Mr. Gardner concluded a very interesting evening with a film, recorded with the aid of this equipment, showing ionospheric conditions during a period of severe sunspot activity. The meeting concluded at 9.30 p.m. after a vote of thanks to the speaker had been led by Mr. Tulloch.

Later in September, a visit was paid by members to the Riccarton electric totalizator building where the totalizator engineer, Mr. R. T. Watkinson, provided one of our most interesting evenings by describing and demonstrating this intricate electrical-mechanical equipment. After the demonstration, a much appreciated supper was provided. The meeting closed at 1.20 p.m. after a vote of thanks proposed by Mr. Anderson had been enthusiastically carried.

October Meeting: A special meeting in the Electronics Laboratory took place early in October where over 30 members and friends had a most instructive evening through the courtesy of Mr. B. T. Withers. Demonstrations of equipment included poly-phase investor, industrial servo-mechanism, H.F. dielectic heating, domestic electricity supply load control, ignitron control of resistance welding, radio broadcasting principles, M.F. eddy current heating.

Addresses: Information regarding the following members is required. Would any person able to assist in this respect please advise the District Secretary in Christchurch, Mr. A. V. Butcher, 236 Riverlaw Terrace, St. Martins.

Mr. W. G. Hooper, who has left the New Zealand Broadcasting Service, and is believed to have joined the Civil Aviation Department, Wellington.

Mr. R. L. Blair, who changed his address some three months ago, without leaving a forwarding address.

DUNEDIN BRANCH

Recently a meeting of members of Dunedin branch heard a description of a radio controlled, mobile electric range, built in receiver and speaker. This electronic equipment was designed and installed by Mr. W. L. Shiel. A full explanation of the circuits used and of the difficulties experienced and overcome in their application provided those present with a very pleasant evening and at the conclusion a hearty vote of thanks was passed to the speaker.

WELLINGTON BRANCH

On Monday, 9th October, 1950, at 7.45 p.m., Mr. S. W. McDonald, of the Engineering Section, New Zealand Broadcasting Service, demonstrated magnetic recording on modern high quality recording and reproducing equipment. In view of the acoustical value of such a demonstration the large attendance appreciated very much the valuable information given by Mr. McDonald and supper concluded an interesting evening.

Accessions to Branch Library: On behalf of the Wellington Branch, the management Committee acknowlgdee with thanks, the receipt of the following books and magazines, from branch members, for our library.

Donated by Mr. R. E. Grainer (A.I.) A.W.A. Technical Review, Vol. 1, No. 1.

Donated by Mr. R. E. Grainger (A.M.) A.W.A. Tech-Ray Oscilloscope," a 44-page book by W. E. Miller, M.A., M.Brit.I.R.E., giving the theory and operation of cathode ray tubes and their application in measurement of voltage, phase relationships, and frequency. A description of time bases and suitable amplifiers, sections on tracing hum and distortion and receiver alignment are included.

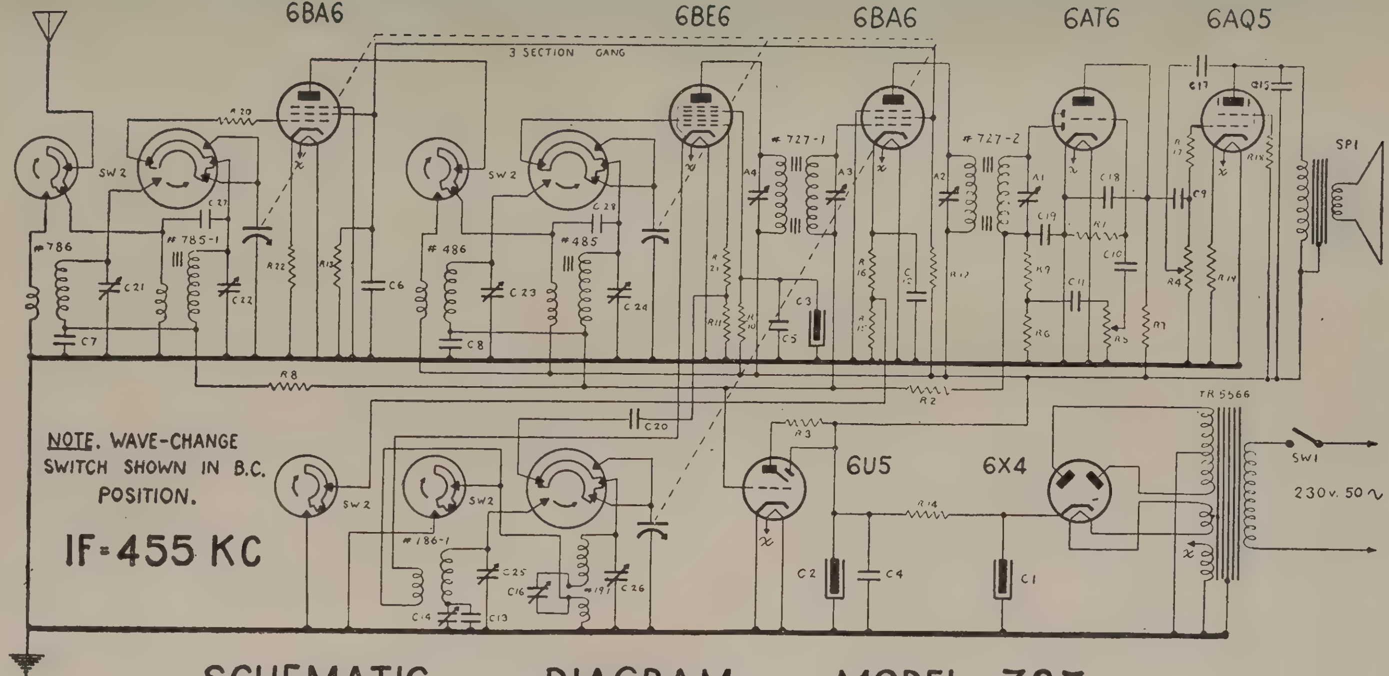
Donated by Messrs. Richardson, McCabe & Co. Ltd., per Mr. W. J. Sutherland (A.): All available back copies of "Technique" by Muirhead and Co. Further issues of this publication will be sent to us as they come to hand.

Regular and Other Additions:

"Radio and Electronics," Vol. 5, No. 7 (Sept., 1950).
Philips "Electronic Measuring," Vol. 3, No. 2.
"Philips Bulletin" May-July, 1950.

(Continued on Page 48.)

FOR THE SERVICEMAN—The Gulbransen Model 727



SCHEMATIC DIAGRAM MODEL 727

VOLTAGE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
R.F.	6BA6	0	0	0	6.3 A.C.	215 v.	85 v.	.8 v.	
Conv.	6BE6	—4 v.	0	0	6.3 A.C.	215 v.	90 v.	0	
I.F.	6BA6	0	0	0	6.3 A.C.	215 v.	85 v.	5.6 v.	
Det-AF.	6AT6	.4 v.	0	0	6.3 A.C.	0	0	72 v	
Output	6AQ5	0	12 v.	0	6.3 A.C.	208 v.	215 v.	0	
Rect.	6X4	3 35A.C.	0	325 v.	325 v.	0	335 A.C.	325 v.	
Eye	6U5	0	20 v.	0	215 v.	0	6.3 A.C.		

1. D.C. voltage measurements are at 2,000 ohm. per volt—A.C. voltage measured at 1,000 ohm per volt.
2. Socket connections are shown as bottom views.
3. Measured values are from socket pin to common negative. Bandswitch in B.C. position.

RESISTANCE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
R.F.	6BA6	1.8 meg.	0	0	0	16K	12K	75 ohm	
Conv.	6BE6	20K	0	0	0	16K	15K	1.5 meg.	
I.F.	6BA6	1.5 meg.	0	0	0	16K	12K	3.2K	
Det-AF.	6AT6	10 meg.	0	0	0	500K	Inf.	400K	
Output	6AQ5	Inf.	270 ohm	0	0	16K	16K	500K	
Rect.	6X4	315 ohm	Inf.	17K	17K	Inf.	320 ohm	17K	
Eye	6U5	0	1.17meg	1.5 meg.	16K	0	0		

4. Nominal Tolerance on component value make possible a variation of ± 10% in voltage and resistance readings.
5. Volume control at maximum, no signal applied for voltage measurements.
6. Resistance readings in B+ circuits may vary widely according to the condition of filter capacitors.

GULBRANSEN
MODEL 727

TECHNICAL INFORMATION
COVERING
DUAL WAVE RECEIVER TYPE 727

COLLIER & BEALE Ltd., WELLINGTON

TYPE SET—A.C. Supehetrodyne.

TUBES (Seven)—6BA6 R.F. Amp., 6BE6 Converter, 6BA6 I.F Amp., 6AT6 Det.-A.F., 6AQ5 Power Output, 6U5 Tuning Indicator, 6X4 Rectifier.

POWER SUPPLY—230 v. A.C. Rating, 60 watts.

TUNING RANGE—Broadcast, 535-1625 K.C., Shortwave, 5.9 m.c.-19 m.c.

ALIGNMENT INSTRUCTIONS

To set pointer, fully mesh variable condenser and set pointer at last reference mark at left end of dial. Set volume control as maximum and keep output from signal generator no higher than necessary to obtain output reading.

Dummy Antenna	Signal Generator Coupling	Sig. Gen. Frequency	Band Switch Position	Radio Dial Setting	Output Meter	Adjust	Remarks
1 mfd.	High side to pin No. 7 (grid) of 6BE6	455 Kc.	B.C.	High freq. end	Across voice coil	A1, A2, A3, A4.	Adjust for maximum output
R.M.A.	High side to ant.	1400 Kc.	,,	1400 Kc.	,,	C26	,, ,,
Standard	Terminal	1400 Kc.	,,	1400 Kc.	,,	C24 & 22	,, ,,
,,	,,	600 Kc.	,,	Rock Variable	,,	C16	Recheck C26 at 1400 Kc. If C26 is changed recheck C16
,,	,,	18 Mc.	S.W.	18 Mc.		C25	Adjust for maximum
,,	,,	18 Mc.	,,	18 Mc.	,,	C23 & 21	output

CAPACITORS

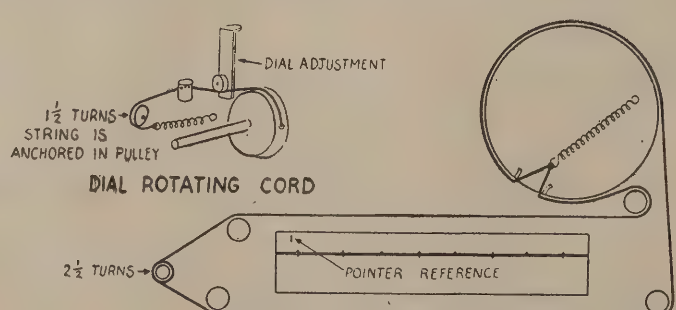
Ref. No.	Cap.	Volts
C1-2	40+40mfd.	450
C3	8mfd.	450
C4-6	.1mfd.	600
C7-8	.05mfd.	600
C9-12	.01mfd.	600
C13	.0035mfd.	mica
C14	1,000mmfd.	padder
C15	.001mfd.	mica
C16	600mmfd.	padder
C17	.0005mfd.	mica
C18-20	.0001mfd.	mica
C21-24	3-30mmfd.	trimmer
C25-26	3-30mmfd.	ceramic trimmer
C27-28	5mmfd.	ceramic

MISCELLANEOUS

Ref. No.	Res., Pri.	Res., Sec.	
785-1	20 ohm	2.4 ohm	
485	69 ohm	2.4 ohm	
191	.24 ohm	2.25 ohm	
786	.4 ohm	.03 ohm	
486	1 ohm	.03 ohm	
186-1	.42 ohm	.03 ohm	
727-1	6.75 ohm	6.75 ohm	
727-2	6.75 ohm	6.75 ohm	
	Volts	**Volts**	**Volts**
TR5566	230	350 aside	2 x 6.3
	Type	**Transformer**	
SP1	8" P.M.	5,000 ohm	
SW1	S.P.S.T. switch attached to R4		
SW2	D.W. bandswitch SW5282		

RESISTORS

Ref. No.	Res.	Watts
R1	10 meg.	½ watt
R2-3	1 meg.	½ watt
R4-5	.5 meg.	pot.
R6	.5 meg.	½ watt
R7-8	.25 meg.	½ watt
R9	50,000 ohm	½ watt
R10	25,000 ohm	1 watt
R11	20,000 ohm	½ watt
R12	15,000 ohm	2 watt
R13	15,000 ohm	1 watt
R14	1,500 ohm	5 watt
R15	1,500 ohm	½ watt
R16-18	500 ohm	½ watt
R19	270 ohm	1 watt
R20	150 ohm	½ watt
R21	100 ohm	½ watt
R22	75 ohm	½ watt



DIAL ROTATING CORD

DIAL CORD DRIVE

TUBE DATA

NEW SERIES OF CRYSTAL RECTIFIERS

We are indebted to Amalgamated Wireless Valve Co. Pty., Ltd., Sydney, for the information given below on a new series of crystal diodes designed for a variety of purposes. These diodes are hermetically sealed in minute glass envelopes little larger than a grain of wheat, with wire leads sealed into the glass. Their price will be considerably lower than that of previous germanium diodes, so that they should become very popular for the multitude of purposes to which these versatile units can be put.

GEX.33—Colour Code: Red/orange.

Suitable for use as rectifier feeding low impedance circuits, such as second detector in wide band amplifiers or instrument rectifier.

Reverse current at —10 volts	less than 1.0 mA
Forward current at +1 volt	greater than 3 mA
Turnover voltage	30/60 volts
Shunt capacitance	1.0 pF approx.

GEX.44—Colour Code: Red/yellow.

Suitable for use as rectifier feeding medium impedance circuits, such as second detector in narrow band amplifiers, limiter in F.M. circuits, or discriminator rectifier.

Reverse current at —10 volts	less than 100 μA
Forward current at +1 volt	greater than 1 mA
Turnover voltage	greater than 60 volts
Shunt capacitance	1.0 pF approx.

GEX.55—Colour Code: Red/green.

Suitable for use as a rectifier feeding high impedance circuits, such as discriminator in F.M. circuits with high output impedance, or rectifier in valve-voltmeter probe.

Reverse current at —10 volts	less than 10 μA
Forward current at +1 volt	greater than 1.0 mA
Turnover voltage	greater than 60 volts
Shunt capacitance	1.0 pF approx.

Note that the GEX.44 is similar to the American 1N34. All types will handle continuously a steady forward current of 30 mA and a recurrent peak of 100 mA with safety. This suggests their use as low voltage bias rectifiers, etc.

In the colour coding system, red is an indication of the negative end of the rectifier. Thus, the direction of easy flow of current is given when the red end is joined to the positive end of the rectifier lead.

The October issue of *Radiotronics* carries a description of these rectifiers

TRADE WINDS

NEW ZEALAND RADIO TRADERS' FEDERATION

The Annual Meeting was held in Wellington on 27th September, Mr. J. Fairclough, President, presiding.

In his report, covering the period ending 31st March, 1950, the President stated that it was now possible to record the relief felt by the business community by the removal of certain enforced regulations and war-time restrictions. A slight improvement in the labour situation is apparent, and the effect of compulsory military training will have to be taken care of and allowances made for the absence of the younger male staff during training periods.

During the year past a special committee has been working on The Traders' booklet, as proposed at the last annual meeting, and a draft is practically completed. A membership badge committee has been engaged on suggestions put forward, and finality of design was reached at this meeting.

Import licenses for 1951 have not been increased over 1950, and some items were actually lowered. The federation proposed to take this matter up with the Licensing Committee. Radio interference was a matter that had yet to be solved and some members asked whether steps could not be taken to keep a closer check on imports of certain classes of machinery to ensure its being equipped with interference suppressors.

Officers elected for the ensuing year:—

President: Mr. J. Fairclough.

Vice-President: Mr. I. R. Cosgrave.

Immediate Past President: Mr. G. J. Markby.

Executive: Messrs. E. B. Borham (representing N.I. Minor Associations), A. K. Griffiths (representing S.I. Minor Associations; four members to be elected by the Auckland, Wellington, Canterbury, and Otago Radio Traders' Associations respectively.

Auditors: Messrs. G. Y. Berry and Miller.

Secretary-Treasurer: Mr. C. G. Camp.

* * *

WELLINGTON RADIO TRADERS' ASSN.

At the general meeting held on 20th September, 1950, the following officers were elected for the ensuing year.

President: Mr. E. A. Peterson (National Electric and Engineering Co., Ltd.).

Executive: Messrs. W. Young (Russell Import Co.), D. B. Billing (Turnbull and Jones Ltd.), H. Bradbury (Fears Radio & Cycle Co.), Preston Billing (Preston Billing Ltd.).

Delegates to N.Z. Radio Traders' Federation: Messrs. D. B. Billing and I. R. J. Cosgrove.

* * *

Don Cooper, Managing Director of Green and Cooper, is now back after a full and intensive five weeks in Britain. Hospitality from the business contacts, says Don, knows no bounds and all with whom he had business gave time and assistance ungrudgingly. Exports at the moment are suffering somewhat from the need to supply defence requirements, but United Kingdom manufacturers look to New Zealand for a good market even under the present difficult conditions, increased exports to New Zealand being of vital importance since the New Zealand meat and wool, still much needed in the homeland, have reached peak prices.

Don Cooper was fortunate in having a box seat to view part of the telecast recently made by the B.B.C. from Calais to Britain. In Cambridge, he says, the reception showed excellent results, specially having regard to distance and the technical difficulties which had to be overcome by the B.B.C. TV. engineers, who took their own equipment to Calais, the resulting picture being sent across the English Channel by V.H.F. radio and from there by special techniques to Alexandra Palace, thence picked up at Cambridge. At the same time it was sent by micro-wave relay stations to Birmingham, and by P. and T. cables to Sutton Colefield for the Midland area. This was the first television broadcast outside the United Kingdom reproduced on English screens.

Production of domestic radios in England is of a very high standard with prices considerably lower than those in New Zealand. In spite of TV going ahead by leaps and bounds, production being between 3000 and 3500 TV sets per week, there is no falling off of ordinary radio sales and manufacturers say that their books are overflowing with orders for all types of sets and much is for export.

The public at Home are appreciating more than ever the higher standard of radio entertainment and with the long playing recordings now available, the demand for the "gram" is increasing.

Among the places visited by Mr. Cooper were the television station at Birmingham, installed for the Radiolympia held there, at Sutton Colefield, the largest television station in the world, and at Nottingham, the Ericcson Telephone Factory, where some automatic exchanges are being built for New Zealand.

* * *

PUBLICATIONS RECEIVED

From Green & Cooper Ltd.: Catalogue of Ericcson Ltd. (Eng.) of telephones, switchboards, and accessories.

Savage and Parsons, Ltd.: Leaflet on "Eduscope" projectors.

Simon Equipment Ltd.: Leaflet on "Long Duration Monitoring."

"PYE" folder "Glass to Metal" seals; descriptive sheet PYE Black Screen Televsion.

"RADIO AND ELECTRONICS"

Back and current numbers of "Radio and Electronics" may be obtained from—

Te Aro Book Depot, Courtenay Place, Wellington.
S.O.S. Radio, Ltd., 283 Queen Street, Auckland.
S.O.S. Radio, Ltd., 1 Ward Street, Hamilton.
Tricity House, 209 Manchester St., Christchurch.
Ken's Newsagency, 133–135 Stuart St., Dunedin.

Letter to the Editor

Sir,—Your issue of July 1950 contained the first part of an article on the home construction of a high-fidelity pick-up, which I read with considerable interest. The principles to be followed in the search for high fidelity were well explained and the method of construction of the model was clearly laid out. Which makes it all the more regrettable, that, as a simple analysis shows, the pick-up cannot be working in the correct manner. That the signal should be as low as one millivolt is not so surprising as that it exists at all.

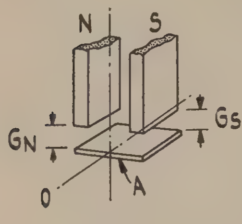


FIG. 1

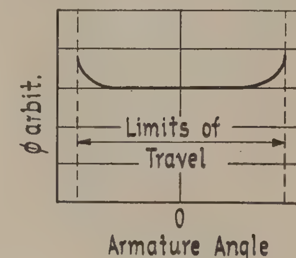


FIG. 2

Consider again the soft iron armature A and its two pole pieces, N. and S. (Fig. 1). The reluctance of the magnetic circuit is the sum of the reluctances of the iron parts, and the two air gaps in series. The iron reluctance remains constant to all intents and purposes, whatever the position of the armature, so it is the variation of the air gap reluctance which we are relying on to vary the flux in the coils. The normal movement of the armature under the action of the stylus approximates to rotating about the axis 0 0. The reluctance of the series air gaps, neglecting fringing for the moment, varies as the sum of the lengths ($g_n + g_s$) which is to the first order, unaffected by changes in the position of A. Thus if fringing is neglected, we can expect no change of flux with rotation of A. However, since fringing can evidently not be neglected for air gaps of these proportions, and probably rotation is not exactly about 0—0, the flux will not be quite constant. Without carrying out a strict analysis or measurement, I should expect that the reluctance would show a flat maximum when the armature is central, and a slight fall at either end of its travel. Thus the variation of flux through the coils would be approximately as in Fig. 2.

If this picture is correct, then the output I would expect from the coils would be (*a*) very low, and (*b*) double frequency.

Thus I am forced to the conclusion that the output which was observed at the correct frequency is entirely due to the vertical compliance of the stylus, since vertical movement of the armature does vary the flux in the correct manner, and it is only the fact that the pick-up is very insensitive to lateral movement of the stylus that prevents the generation of a severe second harmonic.

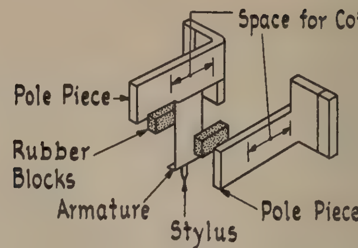


FIG. 3

A design which seems, with trying, as more promising and no more difficult to make, is shown in Fig. 3. I think cementing between the rubber and the pole pieces and armature would probably be enough to hold it together. The compliance might be too high as shown, but could be altered by changing the width of the rubber blocks.

Yours faithfully,

A. G. BOGLE.

The Philips Experimenter

(Continued from Page 24.)

over a wide frequency range, such as the two-to-one needed to make a general-coverage instrument. It will have been noticed by users of the circuit that even when bandspread over a narrow band like the 80-metre amateur band, there is a decided change of grid current as one tunes from one end to the other. To make it work satisfactorily over a wide range is thus difficult, but it was felt that the accuracy of the instrument, and also the ease with which it can be used, would be so much improved, first by using the Clapp circuit and secondly by bandspreading, that both these were decided upon.

It will be noted that, apart from a rather numerous selection of separate condensers in the tuning section, the circuit of the variable oscillator is a conventional Clapp oscillator with the output taken from the plate. Our first job, then, is to explain what all these condensers are for. First of all, we have the usual large condensers (in this case 0.001 μf.) between grid and ground, with the cathode of the oscillator valve connected to their junction, and the D.C. cathode return circuit provided by an R.F. choks, R.F.C.$_2$ Then, from the lower end of the coil to earth, we have no less than four condensers, and a switch which alters their connections slightly. This switch is the band switch, and has only two positions. One of these is used for the 80 and 10-metre bands, while the other is used for 40 and 20. Simple parallel bandspread is used. The parallel capacity is provided by a 100 $\mu\mu$f. fixed condenser on 80 and 10, and by this and a further trimmer (pre-set) on the other bands. The remaining two condensers shown are the sections of a midget split-stator variable condenser, and this is the one to be driven by the dial.

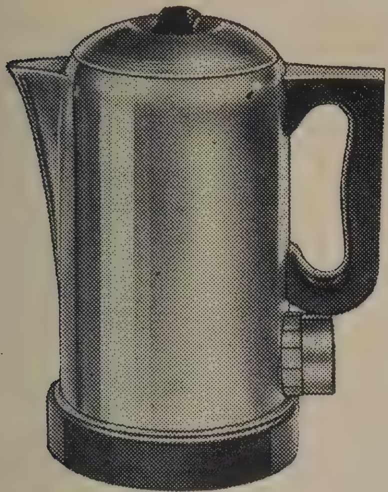
On one position of the switch—namely, that for 80 and 10—both sections are used in parallel. In the other position, one-half is put out of circuit and is replaced by a pre-set condenser which has the same capacity as the maximum of the section it replaces. By this means, the total circuit capacity is the same on all bands, while the variable portion is halved for the narrow bands, 40 and 20, giving greater bandspread than would otherwise be obtained. This makes it clear that the variable oscillator is kept to the same frequency band for measurements on all bands, harmonics being used for all except 80, where the fundamental is used. The arrangement described for varying the degree of bandspread has the advantage that the low-frequency end of each band comes

on the same dial reading. This is because the low-frequency ends on all four bands are in harmonic relationship.

There is another variable condenser connected with the oscillator circuit that has not yet been mentioned. It is the 50 $\mu\mu$f. variable shown connected in parallel with the lower 0.001 μf. condenser of the voltage divider. This is a convenient means of giving a very slight adjustment to the oscillator frequency. The control is brought to the front panel, and its use will be fully described in the section of this article dealing with the setting-up and use of the meter. Briefly, it enables the variable oscillator to be "pulled" by only a few hundred cycles per second, and is used in conjunction with the crystal oscillator. The latter is turned on, after which the variable oscillator is tuned to the correct dial setting for one of the check points. This done, it will probably be found that a beat exists. The 50 $\mu\mu$f. condenser is then used to bring the variable oscillator to exact zero beat *without touching the setting of the calibrated dial.* We thus have the correct dial setting, and the correct frequency, and this process enables small changes in calibration to be taken up at the time a measurement is being made. It ensures that the variable oscillator is always referred to the crystal oscillator, and greatly increases the accuracy of the meter.

(To be continued.)

ULTIMATE "SAFEGUARD" ELECTRIC JUG, MODEL No. 325



A 3-pint jug of spun copper heavily chromium plated. Robust 1500-watt element fitted with exclusive double earthing safety clip. Black moulded handle and base give pleasing contrast. Exceptionally fast boiling jug.

Special feature is safeguard clip and base — anchors jug to bench whilst in use—protects kiddies from accidental scalds if flex is pulled or jug knocked. Jug slides on and off clip quite easily. Recommended by highest health authorities. Price £3 15s. retail.

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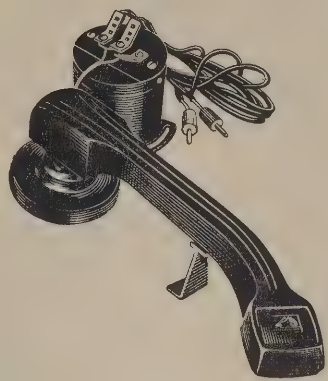
"HIS MASTER'S VOICE" LIGHTWEIGHT PICK-UP No. 14 H



This high quality instrument for fidelity reproduction from gramophone records will at once make apparent the advances in modern recordings. It is designed to cover a very wide frequency range with the absolute minimum of record and needle wear. The specially designed movement holds miniature steel or sapphire needles firmly in a "V" groove, eliminating the need for a securing screw. The total weight of the armature is thus greatly reduced which improves the frequency response and eliminates undesirable resonances in the musical range. The transformer supplied incorporates a tone compensation circuit and provides an output sufficient to give a reserve of volume with almost any radio receiver.

Weight at needle point .... $1\frac{1}{2}$ oz. approx.

WANTED SELL—Capacity Analyser, £15, Vacuum Tube Voltmeter, £15; Test Speaker, £13. All as new. Will consider terms. Miller's Radio Depot, Te Awamutu.

Pick-up output for average record ...... 6mV.
Output at secondary of matching transformer (on average record) .... 1.5 volts
(Sufficient for fully loading most types of wireless sets.)

The frequency response of the pick-up extends over the whole recorded range and is sensibly linear over the section 50–8,000 c/sec.

Ordinary needles must not be used with this instrument. Recommended types are the "His Master's Voice" Silent Stylus or "His Master's Voice" Permanent Sapphire.

Retail price £3 7s. 6d.

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Tape Recording

(Continued from Page 7.)

they give a very constant speed of drive to the capstan. In order to help out, it is usual to have a fairly large and heavy flywheel on the same shaft as the capstan. In fact, the flywheel and capstan are usually cast and turned out of the same piece of metal—usually brass. Since the capstan diameter need not be very great, not a great deal of speed reduction is needed from a synchronous A.C. motor, so that the whole drive system for the capstan can consist of a single rubber-tyred wheel bearing on the rim of the flywheel, on the one hand, and on the motor shaft on the other. The capstan is provided with a long bearing so that it will run very true, and the weight of the flywheel and capstan is usually taken by a thrust bearing consisting of a single ball. Fig. 9 gives an idea of a practical capstan driving system, and of the construction of the capstan itself. Not very much motor power is needed, and if one is thinking of building a mechanism a very good starting point is one of the rim-drive gramophone turntables that can be bought at present. This gives the motor, the rubber-tyred drive wheel, and a supporting plate for the motor, leaving only the capstan and some distance-pieces to make. The latter will be needed for mounting the motor to a base-plate, as illustrated in Fig. 9.

(To be Continued.)

Miniature Electric Motor

(Continued from Page 14.)

simple ones, and anyone with moderate skill with a soldering iron should have no difficulty in duplicating the motor. The beauty of it is that all the steps that would have been very difficult, such as the alignment of the bearings, are made easily, if not automatically, if the method described is followed. Next month we will complete the description of the motor, and, we hope that of the gearing and mounting, too.

(To be continued.)

Amateur TV

(Continued from Page 5.)

to that on the transmitting tube. Because of this, the light and shade produced on the receiving tube *corresponds exactly in position* to the light and shade on the original transparency, and the picture is reproduced. In standard television transmission, it is not possible to send out the actual deflecting wave-forms as part of the transmission, but instead, each receiver has to make its own saw-tooth deflecting voltages. In order that the picture may be a stationary one, therefore, the locally-generated deflecting voltages must be exactly synchronized with those of the transmitter. This is accomplished by sending out *synchronizing pulses,* which are received along with the brightness signal, and made to keep the receiver's raster in step with the transmitter's one.

However, the above description shows that to show a picture on the screen of a C.R.T., synchronizing difficulties may be avoided by sending the deflecting waveforms directly to the receiving tube, and this is what we propose to do in our first part of the "'R. & E.' Amateur TV Project."

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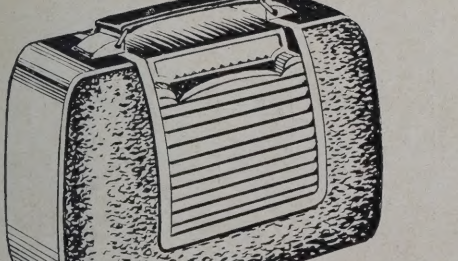

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